DEC 14 1923

VOL. 16 DECEMBER, 1923 NO. 6

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

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PUBLISHED BY
AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS
GENEVA, N. Y.

Entered March 14, 1921, as second-class matter at the Postoffice at Geneva, N. Y., under the Act of Congress of March 3, 1879.

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VOL. 18 DECEMBER, 1925 No. 6

SPECIFICITY IN BACTERIAL DISEASE WITH SPECIAL REFERENCE TO SILKWORMS AND TENT CATERPILLARS

By R. W. GLASER, *Department of Animal Pathology, Rockefeller Institute for Medical Research, Princeton, N. J.*

ABSTRACT

The silkworm disease bacillus which is also pathogenic for tent caterpillars produces a specific disease in the two insects when their food is contaminated with the microörganism. This disease cannot be reproduced by contaminating the food with bacteria of general occurrence or with those pathogenic to other insect species. By contaminating the food with other bacteria a few deaths are obtained but these deaths in no way resemble those produced with the silkworm bacillus, and epidemics cannot be initiated. All insects investigated (silkworms, tent caterpillars, army worms, grasshoppers, roaches, etc.) succumb in a few days when inoculated with living cultures. Such a procedure, however, throws little light on the nature and course of a naturally acquired infectious disease in insects.

Beginning with Pasteur in 1870 (1) up to the present time several species of bacteria have been described as the cause of specific diseases in silkworms. Forbes (2), Cohn, Macchiali (3), Paillot (4), Glaser (5). Sawamura (6), on the other hand, in 1906, claimed that he could produce death in silkworms by infecting them with almost any bacterium of general occurrence, and other workers have from time to time drawn inferences from these experiments to explain the bacterial affections of this insect. Sawamura's observations have been verified many times by the present writer. When silkworms, tent caterpillars, or any other lepidopterous forms are inoculated with large doses of any living bacterium they invariably succumb in a few days. An open circulation immediately distributes the organisms which rapidly multiply and overwhelm the host. Such a condition, however, has little in common with the acquisition and development of natural disease. Ingestion of microörganisms with the food is the only manner of bacterial infection so far known in insects and, therefore, it appears necessary to imitate the natural mode of infection during experimentation.

Silkworms and other herbivorous lepidoptera, when reared on their normal food plants, have scarcely any intestinal flora. In such forms

it is often extremely difficult to obtain cultures of bacteria from the gut and nearly always impossible to find bacteria in sections or films prepared from the various parts of the alimentary system. For this reason, as well as for the reasons stated above, it was thought possible that healthy silkworms and other normal herbivorous lepidoptera might be extremely sensitive to almost any bacterial activity occurring within the intestinal tract. In other words, although unlikely, the possibility existed that any bacteria might produce disease in such larvae when conditions within the host became favorable to the bacteria.

The bacillary septicemia in silkworms, described by the writer in 1924, offered the opportunity to compare the behavior of this disease with diseases produced by adding to the food various species of bacteria. Incidentally, the American tent caterpillars were also found to be highly susceptible to the silkworm bacillus and were therefore likewise drawn into the experiments.

A large series of experiments was performed by contaminating the food (mulberry leaves) of silkworms and the food (apple or cherry leaves) of tent caterpillars with seven species of bacteria. The bacteria used were: a variety of *Bacillus coli* derived from the intestine of calves; *Staphylococcus pyogenes aureus*, and *albus; Coccobacillus acridiorum*, varieties "*Souche Cham*" and "*Souche Sidi;*"[1] *Staphylococcus muscae;*[2] and a motile, spore-bearing and proteolytic bacillus which is a common inhabitant of house flies in this vicinity. Each experiment was accompanied by a similar group of silkworms and tent caterpillars infected by adding to their food the silkworm bacillus. Uninfected controls were also held.

Among the uninfected controls none died. The groups of silkworms and tent caterpillars infected with the silkworm bacillus yielded the usual high mortality among the larvae and pupae. (Twenty-five matured out of 160 infected individuals.) These deaths were all typical with the characteristic post-mortem appearances, including the darkening of the skin and complete lysis of all the tissues. Stained films and cultures demonstrated that the silkworm bacillus was the dominant form present in the cadavers; indeed, in many cases it was the only form demonstrable.

The groups of silkworms and tent caterpillars infected with either the colon bacillus, or *Staphylococcus pyogenes aureus*, *albus*, *muscae*, or the

[1]Pathogenic to grasshoppers.
[2]Pathogenic to adult house flies.

bacillus from flies all survived and matured. (One hundred infected and 100 moths emerged.)

Out of 15 tent caterpillars and 15 silkworms infected with *Coccobacillus acridiorum*, strain "*Souche Cham*," no tent caterpillars and two silkworms died. Out of 15 tent caterpillars and 15 silkworms infected with *Coccobacillus acridiorum*, strain "*Souche Sidi*," one tent caterpillar and four silkworms died. These seven deaths did not resemble deaths from disease caused by the silkworm microörganism. The skin remained tough and white for several days after death, and the tissues did not liquefy but the worms shriveled and became mummified later. Before death the blood was flooded with the *coccobacilli*. This disease did not assume the form of an epidemic among the experimental animals, in contrast to those infected with the silkworm bacillus, among which one or two deaths occurred each day after the first death.

References

1. Pasteur, L. M. 1870. Études sur la maladie des vers à soie. La Flacherie. Tome 1er; pp. 207–317.
2. Forbes, S. A. 1886. Studies on the contagious diseases of insects. Bull. Ill. State Lab. Nat. Hist., ii, pp. 257–321.
3. Macchiali, L. 1891. Le Stazioni Sperimentale Agrar. Ital. xx.
4. Paillot, A. 1922. Les maladies bactériennes des insectes. Ann. des Epiphyties, viii, pp. 95–276.
5. Glaser, R. W. 1924. A bacterial disease of silkworms. Journ. Bacter., ix, pp. 339–352.
6. Sawamura, S. 1906. Note on the bacteria pathogenic to silkworms. Bull. Coll. Agri., Tokyo Imp. Univ., vii, p. 1.

THE EFFECT UPON THE VITALITY OF SEED CORN OF TEMPERATURES THAT WILL KILL SEED INFESTING INSECTS

By H. W. Alberts,[1] *Department of Agronomy, University of Wisconsin, Madison, Wisconsin* and W. P. Flint, *Entomologist, Natural History Survey, Urbana, Illinois*

Abstract

Tests conducted with corn infested by various species of common seed infesting insects have shown that temperatures of at least 125°F. for three hours are necessary to kill all stages of these insects. Such temperatures have a detrimental effect on the germinating power of both sweet and field corn where the moisture content of the corn is above 15%. Apparently there is no injury to corn of either kind where the moisture content is between 2 and 15%. Corn held in most seed houses will come within these limits.

[1]Arrangement of names alphabetically.

This investigation was undertaken to determine the effect of heat treatment upon the vitality of seed corn, with various moisture percentages, when subjected to a temperature which is high enough to kill insects that attack corn in storage.

It has been known for some time that insects which attack seed corn can be killed if subjected to high temperatures for several hours. The effect of such temperatures on the vitality of the seed corn is not as well known. Heat treatment as a means of insect control has proved effective, but care must be exercised in its application to prevent impairing the vitality of the seed corn, especially when the moisture content is high.

Materials and Methods

The insects used in the tests were taken from heavily infested corn kept in a large container in the dry basement of a building. The insects and corn were placed in tin boxes 2½ inches in diameter and 1 inch high, and the covers placed on the boxes. The boxes were placed in the same ovens with the boxes containing the corn used for the germination tests. The moisture content of the insect infested corn was 10½ per cent of the total weight.

To test the effect of different temperatures on insects infesting corn, 4 ounce tin ointment boxes were filled with corn heavily infested with some of the more common stored grain pests. Each box contained at least ten adults of the common Granary Weevil, *Calendra granaria*, the Rice Weevil, *Calendra oryzae*, and the Confused Flour Beetle, *Tribolium confusum*. Larvae of all three of these above species, also larva of the Mediterranean Flour Moth, *Ephestia kuehniella*, Indian-Meal Moth, *Plodia interpunctella*, and of the Angoumois Grain Moth, *Sitotroga cerealella*. Adults of the Foreign Grain Beetle, *Cathartus advena*, and of the Rough Necked Grain Beetle, *Silvanus surinamensis* were also included in some of the boxes together with the larvae of these species. In the first test, five boxes containing these insects were exposed in electric ovens, and held there for periods of three and six hours at 100°F. These tests showed a kill of a very few larvae and adults of any of the above species. Tests at 120°F. for three and six hours gave a slightly higher kill, averaging about 50% of the adults of the above species, and a little more than 50% of the larvae. The eggs were apparently all killed at this temperature for a period of six hours. Four tests at 125°F. for three and six hours gave 100% kill of all insects used in all stages. The insect infested corn was left in the tin boxes for twenty-six days, and then carefully examined to see if any eggs of insects had hatched. No living insects of any stage were found. Five tests at 130°F. for three and six hours gave a like result, all stages of the insects used being killed at these temperatures for the given exposures. The results obtained in

this experiment, so far as kill of insects was concerned, correspond very closely with those obtained by other experimenters.

Both sweet corn and dent corn were used for the germination test. All lots were free from insect infestation. The varieties of sweet corn were "Evergreen" and "Country Gentleman," obtained from the seed storage houses of three of the large canning companies in central Illinois. The dent corn was a strain of Reid's Yellow Dent grown at the Illinois Agricultural Experiment Station. The moisture content of the sweet corn when received was 10½ per cent of the total weight. In order to raise the moisture content progressively, two samples were suspended daily, one at 8:00 A. M., and the other at 5:00 P. M., above water in sealed jars at a temperature of 86°F. This was continued for one week so that at the end of the period, there were 15 samples with various moisture percentages.

At the end of this period all the samples were removed and their moisture content was determined by removing about 20 grams of kernels from each sample, and drying them in an oven for 10 days at 220°F. The samples were placed in tin containers each holding about 50 kernels. The containers were covered and placed in ovens at 110°F., 120°F., and 130°F. respectively. At the end of three hours, half of the containers were removed, and the heating of the remainder was continued for another three hours. The corn was left in the laboratory for two days and placed on the germinator which was kept at a temperature of 80°F. After a period of one week, the test was read. The results are reported in Table 1.

TABLE 1.—PER CENT GERMINATION OF SWEET CORN SUBJECTED TO DIFFERENT TEMPERATURES

Per cent moisture	Per cent germination					
	110°F.		120°F.		130°F.	
(total wt. basis)	3 hrs.	6 hrs.	3 hrs.	6 hrs.	3 hrs.	6 hrs.
10.6	100	100	100	100	100	80
15.6	100	100	100	100	90	80
17.7	100	100	95	95	90	100
18.5	95	95	95	100	0	35
18.7	100	100	100	100	70	0
19.3	95	100	100	85	35	0
20.0	100	90	100	95	40	0
24.6	100	85	100	90	0	0

DISCUSSION

A temperature of 110°F. or 120°F. for a period of either three or six hours did not affect the vitality of the seed corn nor was this temperature

for the same period fatal to a large per cent of the insects. A temperature of 130°F. for three hours caused the corn kernels to germinate irregularly, and many of those that germinated, showed a weakened condition. All the kernels with a moisture content above 18.5% were dead when heated at 130°F. for six hours.

Another lot of corn with various percentages of moisture was then prepared by suspending it above water at regular intervals. This corn was then subjected to a temperature of 125°F. for three and six hours respectively. The results obtained are shown in Table 2.

TABLE 2.—PER CENT GERMINATION OF SWEET CORN SUBJECTED TO 125°F.

Percent moisture (total wt. basis)	Per cent germination	
	3 hrs.	6 hrs.
8.0	100	100
13.7	70	100
15.4	100	100
17.5	100	90
19.6	100	80

The germination test showed that sweet corn subjected to 125°F. for three hours or six hours was not reduced in vitality. The reduction in percentage of germination was due to causes other than heat treatment. All insects in any stage of the species tested were killed when subjected to 125°F. for three hours or six hours.

Dent corn was used in the following test. The corn had been suspended over different concentrations of sulphuric acid for four months. Different relative humidities were thus obtained which resulted in different moisture percentages in the corn. One set of samples was stored near a radiator in a heated room at a temperature of approximately 110°F. to 115°F. during the entire period, and the other set of samples was stored in an unheated room at a temperature of approximately 30°F. to 50°F. At the end of the period of four months, the samples were subjected to a temperature of 135°F. for three hours and six hours respectively as indicated in Table 3. A germination test showed that all kernels were viable before they were subjected to heat treatment.

TABLE 3.—PER CENT GERMINATION OF DENT CORN SUBJECTED TO 135°F.

Stored at 30°F. to 50°F.			Stored at 110°F. to 115°F.		
Per cent moisture (total wt. basis)	Per cent germination 3 hrs.	6 hrs.	Per cent moisture (total wt. basis)	Per cent germination 3 hrs.	6 hrs.
7.5	100	100	1.5	100	100
10.1	100	100	5.0	100	100
11.6	30[1]	100[1]	6.3	100	100
12.9	60[1]	10[1]	8.1	100[1]	100[1]
15.7	0	0	10.8	0	30[1]
16.2	0	0	11.4	0	0

[1]Very weak.

Table 3 shows that corn which was subjected to 135°F. did not lose its vitality if it was stored in a cool place with the moisture content at 10 per cent or less, or if it was stored in a warm place with a moisture content of 6% or less. Owing to the variations in the storage temperatures, the results obtained in the last test should be interpreted from a qualitative instead of quantitative viewpoint.

Summary

1. A temperature of 125°F. for three hours killed all the stored grain insects included in these tests. Corn which had a moisture content of approximately 8 per cent to 19 per cent, and which was subjected to the same temperature for the same period of time, did not lose its vitality.

2. The maximum amount of heat that may be applied to corn without injuring its vitality, depends not only upon its moisture content at the time of treatment, but also upon the previous storage temperature. The determination of the limiting moisture percentages and temperatures, requires further investigation.

Review of Literature

Goodwin, W. H., reported that wheat, after having been subjected to 150°F. for two hours, germinated as well as untreated wheat from the same lot. Peas and beans were raised to a temperature of 140°F. for 20 minutes and were apparently uninjured as they germinated almost as well as an untreated sample from the same lot. He stated that there is a possibility that damp seed might be injured by being raised too rapidly to such temperatures. He found also that the drier the air, the less will be the amount of heat required to reach the killing point for the insects. A temperature of 125°F. was sufficient to kill all stages of insects infesting flour mills. "Flour Mill Fumigation." Ohio Agr. Exp. Sta. Bul. No. 234, 1912; "Some Factors Affecting Results in the Use of High Temperatures for the Control of Insects Injuring Cereal Products." Jour. Econ. Ent. 7: 313–322, 1919; "Heat Control for Cereal Insects." Ohio Ag. Exp. Sta. Bul. No. 354, 1922.

Hinds, W. E., found that occasionally the natural heating of immature or damp corn is sufficient to kill insects, but that the effect of heating in this manner may be more harmful than beneficial. "Reducing Insect Injury to Stored Corn." Jour. Econ. Ent. 7: 203–210, 1914.

Dean, G. A., suggested that a temperature from 118°F. to 125°F. is sufficient for killing insects in flour mills, but did not recommend heat treatment for seed houses. "Methods of Controlling Mill and Stored Grain Insects." Kansas Agr. Exp. Sta. Bul. 189: 139–236, 1913.

Harrington, G. T. and Crocker, W. H., found that when seed of wheat, barley, Sudan grass, Kentucky blue grass, and Johnson grass were dried to less than 1 per cent moisture, the germination was not materially changed, and when the moisture was reduced to 0.1 per cent and heated for six hours at 212°F., the per cent of germination was not materially affected. "Resistance of Seeds to Desiccation." Jour. Agr. Research 14: 522–532, 1918.

Crocker, W. H., also found that there is a likeness between the life duration of wheat, at temperatures above 122°F. and the coagulation time of proteins. At given temperatures, the life duration fell with increased water content. Results showed that the life duration is a logarithmic function of the temperature. "Mechanics of Dormancy in Seeds." Amer. Jour. Bot. 3; 99–120, 1916.

Lepeschkin, W. W., found that there is a definite relation between the heat duration, and the death point of seeds. "Zur Kenntnis der Einwirkung supramaximaler Temperaturen auf der Pflanze." Ber. Deut. Bot. Gesell. 30: 703–714, 1912.

Popenoe, C. H., reported that peanuts exposed six hours to a temperature of 140° germinated better and more quickly than those unheated. "Weevil-Cut Peanuts." U. S. Dept. Agr. Bur. of Ent. Cir. No. 142, 1911.

Waggoner, H. G. "The Viability of Radish Seeds as Affected by High Temperatures and Water Content." Amer. Jour. Bot. 4: 299–315, 1917.

REPELLENTS AND LARVICIDES FOR THE SCREW WORM AND OTHER FLIES

By F. C. Bishopp, *United States Bureau of Entomology*, R. C. Roark, *United States Bureau of Chemistry*, D. C. Parman, *United States Bureau of Entomology*, and E. W. Laake, *United States Bureau of Entomology*

Abstract

Methods are described and a list of the more promising repellents given. The repellent action of tear gas has been demonstrated though no satisfactory diluent has been found.

For several years the Bureau of Entomology, in cooperation with the Bureau of Chemistry, has carried on experimental work looking toward the development of satisfactory larvicides, repellents and attractants for use in the control of flies affecting livestock. This field has many ramifications and has presented many difficulties which have made progress slow. It is our wish at this time merely to mention a few promising developments.

Benzol (C_6H_6), introduced by us a few years ago as a larvicide against the screw worm, has steadily gained favor and really has no serious drawbacks.

Our tests with repellents designed for use against the screw-worm fly and other blow flies and the house fly are carried out largely by applying a definite amount of a material to a weighed amount of meat placed on sand in an open mason jar and recording the reactions of the flies to these as compared with jars containing untreated meat. Periodic records are made during each day of exposure, of the number of flies of each species in each of the jars and the time when the meat becomes infested.

The more promising materials are then tested on numerous cases of screw worm infestation in animals under natural conditions. Owing to the individual differences in the way the wounds heal it is necessary to test the materials on hundreds of cases before conclusions can be drawn.

In the jar tests it has been found that a high degree of repellent efficiency against all species of flies under observation is exhibited by some of the war gases, such as chloropicrin, (CCl_3NO_2), chloroacetophenone, ($C_6H_5COCH_2Cl$), benzyl bromide, ($C_6H_5CH_2Br$), benzyl chloride, ($C_6H_5CH_2Cl$), p-xylyl bromide ($CH_3C_6H_4CH_2Br$), beta chloroethyl acetate ($CH_3COOCH_2CH_2Cl$), beta bromo ethyl acetate (CH_3COOCH_2-CH_2Br), and chloroacetone ($CH_2ClCOCH_3$). Other materials showing striking repellent value are beta-naphthyl ethyl ether, ($C_{10}H_7OC_2H_5$), nitrobenzene, ($C_6H_5NO_2$), furfural (C_4H_3OCHO), salicylic aldehyde (OHC_6H_4CHO), picric acid, and a number of members of the pine tar group. Among the essential oils, citronella (Ceylon), cade, fennel, and some of the crude camphor oils show the greatest promise. Clove bud oil and clove powder are also strong repellents.

There seems to be no correlation between chemical groups and repellent qualities. For example, among the chlorides we find chloroform ($CHCl_3$) to be decidedly attractive to the screw worm fly while hexachloroethane (CCl_3-CCl_3) is distinctly repellent. It is suggested that with further work it may be found that the chemical compounds can be grouped as repellents by their physiological properties rather than by their chemical or physical characteristics. For example, the first group of repellents mentioned above are all tear gases having strong lachrymatory properties to man. We do not know just how these materials affect the flies but it is evident that they are greatly disliked, since, chloropicrin, for instance, is highly repellent even in dilution of 1 to 100. While chloropicrin has received considerable attention as a fumigant,

we believe its marked repellent properties have not been pointed out previously.

In our jar experiments we have now conducted over 1,200 tests including about 400 different materials or combinations. Observations in each case are made on all species of flies visiting the jars.

The following species have been observed to visit some of the baits in most of the tests: *Cochliomyia macellaria*, *Phormia regina*, *Lucilia sericata*, *Muscina stabulans*, *Musca domestica*, *Piophila casei*, and *Sarcophaga* spp. Some of these species were not present in sufficient numbers, however, to furnish reliable information on their chemotropic reactions.

Although there are some differences in the responses of various species of flies to various materials, it appears that in general the reactions are very similar and that a substance which is markedly repellent to one species has similar effects on the others observed in these experiments.

The efficiency of each material is now being computed in comparison with the checks in respect to degree and duration of repellent effect on flies, protection of baits from infestation, and ovicidal and larvicidal value.

In connection with the spraying of livestock for the horn fly, stable fly, and house fly, we have found chloropicrin to have decided repellent value, but we have not developed diluents with which we feel satisfied.

Experiments with alcohol, benzol, kerosene and other extracts of pyrethrum indicate that this class of sprays has much promise in connection with horn fly control. The destructive action of the carriers on several species of flies is increased by the addition of extract of pyrethrum in amounts as small as 1/10 pound of pyrethrum flowers to the gallon of spray. However, the use of larger amounts of pyrethrum give more satisfactory results. We feel that the logical procedure in the development of sprays against the horn fly, in particular, is to evolve a spray of high toxicity and combine it with the strongest repellent in nonirritant carriers which will render the mixtures safe when used comparatively freely on livestock.

THE RELATION OF FLIES AND FLY SPRAYS TO MILK PRODUCTION

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ABSTRACT

1. The paper presents an initial attempt to measure the decrease in milk production produced under controlled conditions by infestations of the house, stable, and horn flies, *Musca domestica*, *Lyperosia irritans* and *Stomoxys calcitrans* respectively.

2. During one month's confinement in a heavy infestation of horn flies the loss was 1.4 per cent; with house flies, 3.33 per cent; and with stable flies, 9.26 per cent.

3. Continuing the infestation of flies but spraying daily with a bland non-toxic oil type of spray, cattle infested with stable flies lost 21.0 per cent; with horn flies 13.1 per cent.

4. Sprayed with a combination of the above oil and a pyrethrum extract spray the controls without flies lost 4.3 per cent; and cattle infested with stable flies, 12.4 per cent.

Twenty years ago, many of the Experiment Stations, evidently reflecting a popular interest, undertook trials to determine the efficiency of fly sprays in their relation to dairy production. During the past few years, the cycle is evidently repeating itself for the market is flooded with proprietary fly sprays both for dairy and domestic use and the Experiment Station correspondence is burdened with inquiries concerning their efficacy, use, and manufacture.

Public health interests in their attempts to reduce the fly menace in dairies have pleaded with the dairyman to control flies, arguing that they seriously reduced the milk production. It has not been difficult to convince the dairyman who is constantly confronted with the task of milking a stamping, excited herd of fly-ridden cattle that such was the case in spite of the fact that there are no records apparently available that the damage has ever been measured. It was with this idea in view—of measuring the loss in milk production caused by specific flies—that the following experiments were undertaken. As side issues it was planned to determine (1) the effect of one or more types of sprays on milk production both in conjunction with flies and with the spray alone, (2) the effect on the bacterial count, (3) the body weight of the cows, and (4) the amount of feed consumed in the presence and absence of flies.

Eccles (1905) working in Missouri and Beach and Clark (1904) working at the Storrs Station in Connecticut reported trials in which they

sprayed certain cattle with proprietary sprays and found that the sprayed cattle did not give an increased amount of milk. Bishopp (1913) cites an outbreak of stable flies which was said by the dairymen he consulted to have produced a reduction of from 40 to 60 per cent in the milk production. It was our experience that such reports were easy to obtain, but as they omitted all reference to the contributing factors such as temperature, humidity, management, specific flies, etc., it was deemed worth while to run a series of controlled experiments with a small number of cattle as a purely preliminary test and as a guide for future work should the results prove interesting.

With this idea in mind, four stalls, (12 x 12) were constructed in a shed adjoining the University Dairy Barn. These were sheathed around the sides to a height of five feet, the remainder of the walls and the ceiling (9 feet above the floor) was screened with galvanized screen, 14 meshes to the inch. The door was of wood, equipped with a quick-closing spring and shielded by a burlap curtain designed to keep in the captive flies and avoid the entrance of foreign ones.

Four groups of two cows each were selected from one of the college herds and confined in the stalls. The selected cows, with two exceptions, were all at approximately the same stage in their lactation period. Their food, which consisted of the same ration supplied the herd from which they were taken, was weighed at each feeding and that portion which was refused was weighed back. The animals were furnished water from automatic troughs located in each stall. They were milked twice a day, once in the early morning and again at four in the afternoon. At each milking the milk was weighed, samples taken for bacterial count and butterfat test and the temperature and humidity taken.

After keeping the cows confined in the screened stalls for ten days during which time they were free from flies, three species of flies were liberated in the stalls, one species to each, and with one stall remaining free from flies as a control. The flies concerned were those most commonly encountered in the dairy, the common house fly, *Musca domestica* L., the horn fly, *Lyperosia irritans* L., and the stable fly, *Stomoxys calcitrans* L. The initial cultures of the stable fly and the house fly were from bred material. The house flies were reared by packing maggot infested manure into cylindrical wire baskets which were then placed in 10-gallon crocks, the bottoms of which were covered with sand. As the larvae matured they migrated from the baskets and falling into the crocks proceeded to pupate in the sand. The pupae were then held in cold storage at 7°C. until a few days before needed. The stable

flies were bred in this manner to a limited degree only as their larvae had a tendency to migrate out of the baskets before maturity. A more successful procedure was to allow them to come to maturity in stout wooden boxes filled with manure and capture the adults as they sought the light in conical traps. It was possible to collect almost pure cultures of stable fly larvae, the only contaminating flies being *Muscina stabulans* Fallen and *Eristalis tenax* L. Owing to the difficulty of handling sufficient manure to insure a large number of horn flies,—the number breeding in a single deposition of cow manure being insignificant compared to the numbers required,— it was decided to gather them by sweeping with a net from the backs of cattle in the college herd. Later in the experiment it was found possible to obtain large numbers of stable flies in pure cultures by sweeping the inside walls of stables when the temperature became high enough and to obtain house flies in pure culture by trapping. The flies were counted by blowing them against the walls of a screen cage with an electric fan. Squares were marked off on the screen and the flies remained motionless as long as the fan continued to blow.

PLAN OF EXPERIMENT.—During the first ten days (June 5–14) all cows were kept as free from flies as was possible. The few flies that gained entrance during the opening of the doors for feeding and milking were killed mechanically. In the following thirty days (June 15–July 14) flies were liberated in the stalls in numbers indicated on the charts. There then followed a period of one month when the cows in all the pens were sprayed daily as will be taken up later.

CONTROLS.—It is to be expected that as cows pass through their lactation period the amount of milk produced will gradually become lessened. To establish the normal expectancy, the cows in this group were used as the check. The daily milk production of the first ten days that they were under observation was averaged and thirty days later a similar average was taken. Subtracting the last average from the first, it was found that at the end of forty days the normal milk production had lessened 1.9 pounds per cow per day. A group of ten cows having approximately the same lactation cycle was selected from the college herd and their average loss over the same period coincided almost perfectly. With this substantiation we proceeded to use as a base line of expectancy for all cows under experimentation a line starting at the average of their first ten days confinement and passing through a point 1.9 pounds lower on the fortieth day.

It will be noted by a glance at the chart of the milk production of

the controls that during the first forty days of the experiment there are no serious depreciations, the most noticeable drop occurring from June 25 to 28. This period coincides with the expected lag, with the hot wave of June 23 to 26 when the temperature was above 100°F. in the stalls. Summing up the performance of the controls during the first forty days of the experiment which included the period during which the experimental animals were subjected to a ten day period of freedom from flies, followed by a period of thirty days with flies, the controls failed to produce the expected amount of milk by a total of 6.7 pounds. In other words, after allowing for normal depreciation caused by the lengthening lactation period, the amount that fell below the line of expectancy exceeded that produced above the line by 6.7 pounds. This amount was taken as the standard for the depreciation of the experimental cows chargeable to natural conditions such as temperature, humidity, etc.

It may be well to note at this point that there was no correlation between the milk production and the curve of humidity. Normally the humidity curve of this section (Sacramento Valley, California) shows very few departures, but during the course of the experiment several sharp departures of very short duration were noted. Two extreme hot periods intervened, one in June, and the other near the middle of July. During the first period, our controls showed a very slight depreciation and during the second when we were using the college herd as a control no appreciable depreciation was noted in their milk supply. Hence we have taken the depreciation of the first hot period into consideration as it affected our controls but have ignored the second as the controls did not reflect its influence.

Horn Flies (*Lyperosia irritans* L.)—These insects are probably the most noticeable of the flies that annoy cattle and for that reason their importance has evidently been overestimated. In laboratory trials we have never been able to make this species bite more than once a day, the average meal consisting of 3.2 milligrams of blood. The interior valleys of California are not seriously affected by this fly particularly during the months of June, July, and August. The reason for this is undoubtedly explained by the high temperatures and low humidity which tend to dry out their natural breeding places very rapidly and the lack of tolerance of the adult flies to these same conditions. Hot days always diminish the number of flies found on the cattle despite the fact that they change their roosting place from the back to the belly. The coastal counties with their higher humidity and cooler days offer

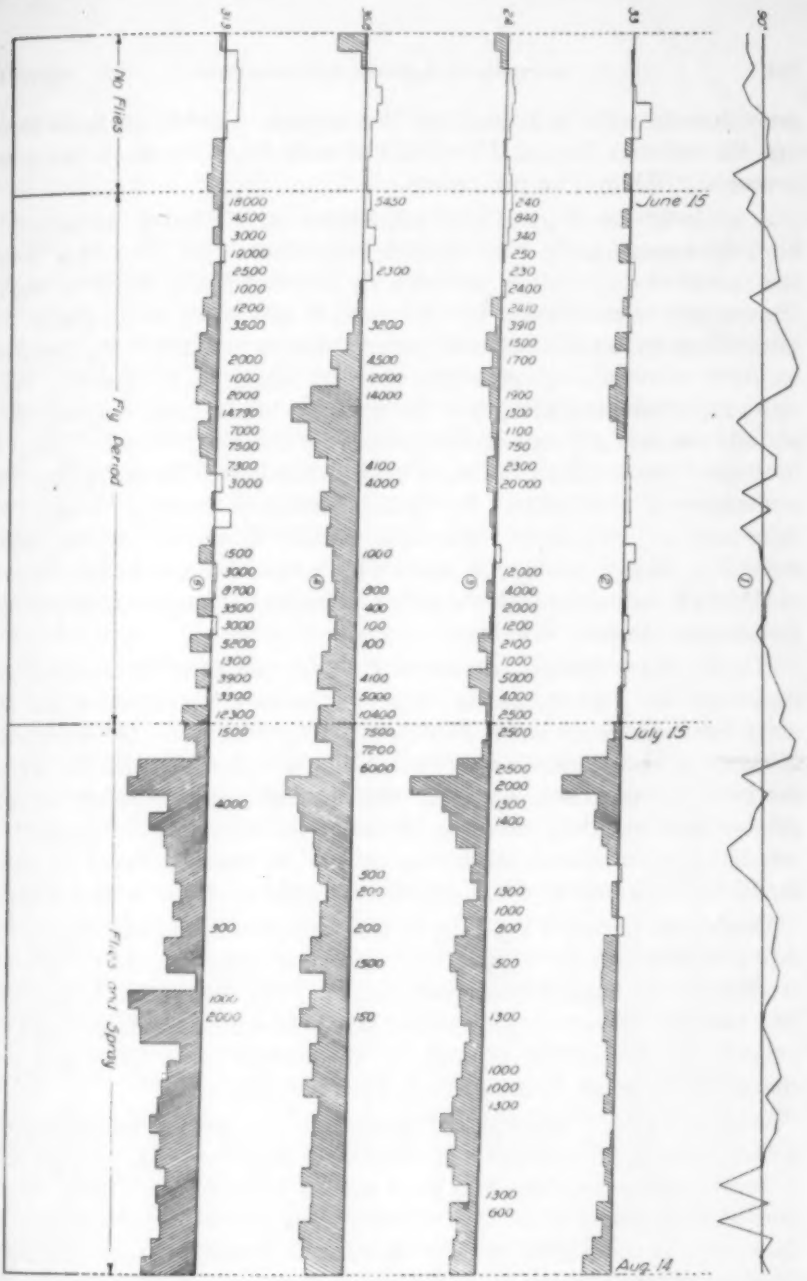

FIG. 22.—DEVIATIONS IN MILK PRODUCTION FROM NORMAL EXPECTANCY.

1, Maximum temperature deviations above and below 90°F.; 2, Control animals without flies; 3, Animals infected with horn flies (*Lyperosia irritans*); 4, Animals infected with stable flies (*Stomoxys calcitrans*); 5, Animals infected with house flies (*Musca domestica*). (During the spray period stable flies were substituted for house flies, July 15 to August 14.) Numbers opposite daily milk returns indicate number of flies put in stalls.

a much more suitable habitat for this species. Counts made on three average summer days at Davis of the horn flies present on ten cows averaged 210 horn flies per animal.

A study of the chart of milk production for the cattle subjected to horn fly attack shows very little depreciation. (See Table 1.) Over the period of thirty days the horn fly infested cattle failed to make their expected production by 16.4 pounds and if we subtract the 6.7 pounds lost by the control cows, presumably on account of the weather, we have a net loss chargeable to horn fly attack of 9.7 pounds. The total expected production for the cows of this experiment was 22.8 pounds per cow per day or 684 pounds for the thirty days. The percentage of loss is therefore 1.4 per cent, so small as to be negligible from a commercial standpoint. It might be assumed that not enough flies were used to bring about noticeable results. However, we used many more flies than were natural under Davis conditions and the addition of 20,000 flies on July first was followed by no decrease in milk production during the next five days.

House Flies (*Musca domestica* L.)—Of the three flies under experimentation, this species is probably the most numerous inside the dairy barns under average conditions. The adults are far more conspicuous at least than those of the stable fly. In our search for larvae for breeding purposes, however, this species was not taken in any greater numbers than were the larvae of the stable fly. Possessed of non-biting mouthparts, these flies depend on exposed liquid or semi-liquid foods and annoy the cattle only by walking about on their bodies.

During the period of exposure to flies, the cows in this experiment fell 36.8 pounds below their expectancy and after deducting the 6.7 pounds attributable to natural conditions, their net loss chargeable to flies was 30.1 pounds. The average expected production for these cows was 29.9 pounds per day or 897 pounds for the month, thus showing a loss chargeable to house fly annoyance of 3.3 per cent.

Stable Flies (*Stomoxys calcitrans* L.)—As previously mentioned, Bishopp basing his conclusions on estimates of dairymen has stated that in severe epidemics these flies have caused a loss of from 40 to 60 per cent in milk production. The adults are not particularly noticeable as they do not congregate on the animals and they are not strikingly different in appearance from the common house fly. The stable fly spends most of its life hidden away on the walls of buildings or on vegetation and comes to the animals for its meal of blood approximately once a day, generally in the morning. The favorite point of attack is

about the legs or belly. A number of stable flies fed in the laboratory required approximately nine minutes to get a complete meal. The average meal consisted of 15 milligrams of blood, a rather astonishing amount when it is noted that the average body weight before feeding was 7.4 milligrams. If the average 150 pound man ate proportionally he would consume 300 pounds of food per day. Another observation that was made during the course of the experiments was that on exceedingly hot days,—when the temperature was above 100°F.,—the stable flies would feed twice, once in the early morning and again in the late afternoon. The average net loss in milk production during the month that the cows were subjected to stable fly attack was 98.4 pounds per cow. The expected production for this period for the cows under test was 1062 pounds. The percentage of loss attributable to stable flies was therefore 9.26 per cent.

Summary of Experiments.—Contrary to our expectations, the horn flies caused a very slight reduction in the milk production, 1.4 per cent being the total. This reduction is negligible from a commercial standpoint, but is nevertheless a true reduction as our Student's odds of 1–49 show that the results obtained were not those of chance but consistent depreciations. The house fly also produced constant depreciation, totalling 3.33 per cent and checked by the Student's odds of 1–347. This damage must be chargeable to irritation and annoyance as, of course, this species is not able to suck blood or to pierce the skin. As expected, the stable fly was the most important pest. The reduction of 9.26 per cent checked by Student's odds of 1–99,999 is equivalent in an average 30-pound milker to approximately 10 gallons of milk per month. The infestation generally persists in this section for at least five months of the year during which time stable flies would have exacted as tribute 50 gallons of milk which at twenty cents per gallon amounts to $10.00 per cow per season for this one pest alone. It is doubtful whether we would be justified in adding the damages of the different species together to arrive at the sum of the fly injury, but if so, the total damage for the three fly pests of the dairy would amount to 14 per cent of the expected milk production.

Spraying.—Despite the fact that the experiment stations have been preaching the doctrine of proper manure disposal and dairy management for years as a solution of the fly problem, the dairymen still prefer to combat the flies on the cows by means of sprays.

Following the month during which the experimental cows were kept constantly infested with flies, a month followed during which time the

flies were still placed in the stalls as before, but efforts were made each day to protect the cattle from their attacks by means of sprays. The only change in arrangements was to substitute stable flies for house flies, the stall previously containing house flies then being known as Stable Fly No. 2.

The sprays used were (1) an odorless, non-toxic, white petroleum oil resembling liquid petrolatum except that it was lighter and less viscid, and (2) a combination of two parts of the first oil and one part of an oil used for household spray containing an extract of pyrethrum in distillate. The first was known throughout the experiment as the White oil and the latter as the Yellow oil, although both are on the market under specific names.

The control cows which had not been subjected to fly attack were still kept free from flies, but were sprayed daily with the Yellow oil as were the cows in Stable Fly No. 1 stall which had been infested with stable flies throughout the experiment. Stable Fly No. 2 cows and those in the Horn Fly stall received daily sprayings with the White oil.

During the first few days of the spraying experiment the material was applied with a hand spray gun, but later an air pressure spray tank was used. Approximately 400 mils. of spray were applied to each cow every day.

Observations of Effect of Spray on the Flies.—The White oil had very little effect on any of the flies. Horn flies caught in the vortex of the spray were killed apparently by the mechanical action. Stable flies were slightly more susceptible to its action than house flies in the case of a "direct hit." Thirty-six out of forty house flies placed in the center of a target that received (at the point where the flies were held) .05 grams of oil per square inch lived longer than controls that were not sprayed. Stable flies were invariably killed by this treatment and when forcing their way through the oily hair of a sprayed cow were often observed to retreat and attempt to clean themselves. House flies, however, were in no way embarrassed by the presence of the oil on the cows. No matting of the hair or gumming with dirt or dust was noticed with any of the sprayed animals, although the oil was noticeable on the animals for over twenty-four hours.

The Yellow spray had a definite toxic effect on the flies that was noticeable for several hours. The pyrethrum-oil portion of the spray was readily volatile, all effects, if used alone, disappearing in approximately forty minutes. When combined with the White oil (the 2-1 mixture that was used in the experiment) it remained effective for three

or four hours, gradually becoming less so until it became innocuous at the end of about six or eight hours. All flies attempting to bite a freshly sprayed cow would either be entirely repelled and not land on the animal or after landing and pushing among the hairs would fall over backward in a state of paresis. About fifty per cent thus affected succumbed, the others gradually regaining control of their appendages until they were apparently recovered. The conditions produced by this oil in the stalls is probably applicable to general conditions in the field, —the flies that were ravenously hungry when introduced attacked the animals in spite of the repellent action of the spray and if they persisted long enough were killed,—but those whose hunger was not stimulating enough to overcome the repellent stimulation of the spray merely waited on the sides of the stall until the action of the insecticide became weak enough to allow them access to the animals

Effect of the Sprays on the Cattle.—As mentioned previously, the physical appearance of the sprayed animals was very satisfactory. The oil was not particularly dust collecting and gave a sleek, soft appearance to the coat that was very pleasing. The milk production, however, was a disappointment. No cattle were confined in stall free from spray as a control but the animals selected from the college herd because their lactation periods corresponded to those under experimentation showed no decrease and, in fact, demonstrated an improvement in milk production over the preceding month. This in itself is sufficient evidence that no untoward climatic conditions were responsible for the losses recorded for the experimental animals.

A glance at the chart tells the story. The inauguration of the spraying program produced a decided drop in production chargeable, no doubt, in large measure to the nervousness of the cows at this strange procedure. The reaction from this decided drop was relatively rapid but never reached the line of expectancy, in fact it remained relatively lower than when the cattle were exposed to flies without the spray. Table 2 summarizes the results. The animals sprayed with the combination of White oil and pyrethrum-oil, the mixture known in the experiment as Yellow oil, apparently suffered less than those sprayed with the straight White oil. Of those sprayed with the Yellow oil, the controls, subjected only to spraying without the presence of flies, failed to make their expectancy by 4.3 per cent. The Stable Fly No. 1 stall which had suffered a 9.26 per cent loss during the previous month from stable fly attacks now showed a decrease of 12.4 per cent, an increased loss of 3.2 per cent. This increased loss corresponds roughly with the loss

shown by the controls of 4.3 per cent which is rightly chargeable to spray injury as no flies were present in the control stall.

With the straight White oil the results are more striking. The cows infested with horn flies which had suffered a reduction of 1.4 per cent with flies alone now returned a loss of 13.1 per cent, an increase of 11.7 per cent. Stable Fly No. 2 cattle, sprayed with White oil, suffered a 21.0 per cent loss as contrasted with a 9.26 per cent loss from stable flies without spray, an increase of 11.74 per cent. It is possible that these figures are more than a coincidence in which case we would be justified in claiming that the Yellow oil caused approximately a 4.0 per cent decrease and that the White oil was responsible for an 11.7 per cent decrease in the production of the sprayed cattle.

Body Weights.—The weights of the cattle were established by weighing each cow at the same time of day on three successive days and accepting the average. The weights were taken every ten days. At the end of the fly period all the cows had lost weight including the controls which had not been subjected to fly infestation. The averaged losses for the two cows in each stall were as follows: controls, 62 pounds; house flies, 57 pounds; horn flies, 75 pounds; and stable flies, 85 pounds.

When the spraying was started, all the cows showed a temporary improvement including the controls which regained 20 pounds in the first ten days. During the same period, the house fly infested cattle gained 22 pounds; those with horn flies, 21 pounds; and those with stable flies, 79 pounds.

This improvement was short-lived, however, for during the rest of the experiment they all lost weight, every individual weighing less on August 11, the last time that the animals were weighed, than when the experiment started on June 5. The average loss was 72.1 pounds with the range from 20 to 145 pounds, the first loss recorded for one of the cows infested with horn flies and later sprayed with White oil and the last loss for a cow infested with stable flies and sprayed with the Yellow oil.

When it is remembered that a normal cow will vary fifty pounds in weight from one day to the next, these differences are not at all significant.

Butterfat Content, Feed Consumed and Bacterial Count.—No correlation was discernable between any of these factors and the presence or absence of flies. With the exception of only two or three days all feed was consumed. When the experiments are repeated, a more careful technique may produce correlated results with the bacterial count.

But two types of the prevailing fly sprays were used, the bland oil and the pyrethrum extract types. Other types such as the pine tar[1] and cresol emulsion types may be superior in value to those under trial, but the logical conclusion that the fly nuisance should be controlled at its source—the breeding places of the flies—seems inevitable.

The authors are greatly indebted to Mr. Leslie Smith, a student in entomology who carried on the routine work concerned with the production and management of the flies used and whose careful observations were extremely helpful, to Mr. George Drumm, the dairy herdsman whose helpful and scientific co-operation made the experiment possible, and to Dr. C. S. Mudge, associate professor of bacteriology and his assistant, Mrs. Whipple who performed the endless examination of the milk samples to determine the bacterial counts.

At this point we wish to emphasize a statement already noted to the effect that this is a *preliminary* report based on but few individual records. Every precaution has been taken to safe-guard and scrutinize the results which have been checked by statistical methods and found adequate but the fact remains that but two cows are concerned in each individual test. The paper is presented, therefore, as a record of accomplished experimentation, the verification of which rests on its repetition. The authors plan to repeat the work during 1926 on a larger scale at which time they hope to determine the underlying reasons for the decreased milk production of sprayed cows and those heavily infested with flies.

TABLE 1.—FLY PERIOD WITHOUT SPRAY

	Expected production lbs.	Actual production lbs.	Gross loss lbs.	Loss from fly attack lbs.	Percentage loss from flies %	Student's odds
Controls (no flies)	954.0	947.3	6.7			..
Stable Flies	1062.0	956.9	105.1	98.4	9.26	1–99,999
House Flies	897.0	860.2	36.8	30.1	3.33	1–347
Horn Flies	684.0	667.6	16.4	9.7	1.40	1–49

TABLE 2.—FLIES AND SPRAY

	Expected production lbs.	Actual production lbs.	Loss lbs.	Percentage Loss %
Controls (Yellow oil)	942.0	870.6	41.4	4.3
Stable Fly No. 1 (Yellow oil)	985.8	862.4	123.4	12.4
Stable Fly No. 2 (White oil)	877.3	691.8	185.5	21.0
Horn Fly (White oil)	654.1	566.2	87.9	13.1

[1]Cory (1917) has shown that a 3 per cent pine tar emulsion seemed to afford considerable relief.

LITERATURE CITED

BEACH, C. L. and CLARK, A. B.
1904 Protecting Cows from Flies. Storrs Agric. Exp. Sta. Bull. No. 32.
BISHOPP, F. C.
1913 The Stable Fly. U. S. D. A. Farmers' Bull. No. 540.
CORY, E. N.
1917 The Protection of Dairy Cattle from Flies. Journ. Econ. Ent., 10:111–113.
ECKLES, C. H.
1905 Tests of a Fly Repellent. Univ. of Missouri, Agr. Exp. Sta. Bull. No. 68: 35–39.

CONTROL OF THE SAW-TOOTHED GRAIN BEETLE IN RAISINS: A PRELIMINARY REPORT

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ABSTRACT

This paper records the preliminary steps taken to control raisin packing-plant infestations of the saw-toothed grain beetle, *Oryzaephilus surinamensis* Linn. The two complementary measures discussed relate to the destruction of beetles concentrated in trash by routine procedure and the protection of storage sheds by metal barriers.

INTRODUCTION

The average raisin plant combines storage features with those of the manufactory. T! processing routine largely frees the fruit from the saw-toothed grain beetle[2] but, where the insects are abundant, packed goods are subject to reinfestation and are therefore commonly fumigated just before shipment. This procedure, valuable as it may be in respect to marketed goods, has no effect in limiting infestations at the plant. This paper deals only with plant infestations.

The problem divides itself naturally into two phases; namely, reducing existing infestations and minimizing the hazard of infestation during storage. The former contemplates the destruction of beetles which have already exercised a detrimental influence upon stored fruit, while the latter has to do with preventing infestation of stored raisins.

I. REDUCING EXISTING INFESTATIONS

As the initial processing procedure, raisins pass through the stemming machine where the great bulk of extra eous matter is eliminated. The lighter waste material known as "stemmer trash" and consisting of sand, chaff, and the small cap-stems is removed on the entrance side of the

[1]This paper was prepared in December 1924.
[2]*Oryzaephilus surinamensis* Linné.

machine, being collected in "picking boxes" immediately in front of the "cylinder." On the average, 3 tons or 120 picking boxes of raw-stock raisins produce about 1 picking box (1.5 cu. ft.) of stemmer trash.

It is in this stemmer trash that the great majority of Oryzaephilus adults collect. Probably less than 5 per cent of the beetles entering the stemmer remain connected with the raisins subsequent to passage through it. Incidentally, goodly numbers of Oryzaephilus larvae collect here also. Early estimates based upon actual counts of small samples made during August indicated the average beetle-content per picking box of trash produced from first-run stored fruit at 15,000. Later estimates showed this figure to be very conservative. During December the beetle-content of a picking box of trash produced from very heavily infested fruit was found, by measure of the collected insects, to be 154,000. Owing to the difficulty of extracting them from the trash this figure is slightly below the actual number.

In the past the insect-laden stemmer trash has been used for roadway improvement at the plant or by growers for land fertilization. In either case the trash has accumulated near the building, allowing the insects to disperse and enter packing and shipping rooms as well as fresh storage stacks. In short, past practices relating to this waste material have tended to perpetuate the plant infestations.

From the above discussion it is clear that, in reducing plant infestations, the most effective single action consists of destroying the beetles while they are so heavily concentrated in the stemmer trash.

Treatment of Stemmer Trash

Several methods designed to eliminate the insect from plant premises have proved undesirable or impracticable. These include: burning, placing on city dumping grounds, sacking as produced for burning or burying away from the plant, fumigation at the plant in boxes beneath canvas with HCN, and immediate and continuous fumigation in a trap-door hopper with calcium cyanide dust. The impracticability of the last two methods was established experimentally.

The requirements of the situation have been met by a cupboard-like fumigatorium designed by the senior author. This chamber is of board and paper construction, fitted interiorly with wooden runners along either side, permitting the placing of picking boxes in shelf-like arrangement. Thus a house measuring (i.d.) 2 feet wide by 8 feet long by 7 1/3 feet high will receive 36 boxes in 6 tiers of 6 boxes each. The tiers are separated by 4 inches, while clearances of 1 foot and 8 inches, respective-

ly, are provided at the bottom and the top of the chamber. Two shallow wooden trays receive the fumigant and are then placed on the floor of the fumigatorium. Such a house will, then, accommodate the production of trash from a plant processing approximately 100 tons of fruit per day.

Because of the density of the material to be penetrated and the difficulty of retaining a heavy concentration of gas in such a structure, calcium cyanide in flake form seemed most promising by virtue of supplying a smaller amount of gas over a longer period, as well as permitting application by hand.

Experimental Testing of Effectiveness of Fumigatorium

For testing, the insects were placed with a small quantity of trash in small cheese cloth bags. Positions selected in the chamber included the end and center boxes on the bottom, lower-middle, and top rows. Location of test-bags in each box was as follows: 1—on top of box, barely covered with trash; 2—in center of box; 3—on bottom of box, midway between sides; 4—on bottom of box, in corner. In one experiment parallel tests were made, using capsules instead of cloth bags. Small capsules, thoroughly perforated with tiny holes, contained the insects, and these were placed together with trash in densely punctured veterinary capsules. Results of these experiments are summarized in Table 1.

Table 1.—Summarized Results of Stemmer Trash Treatment for the Destruction of Adults of the Saw-toothed Grain Beetle

No. of Expt.	Charge per 100 cu. ft. (Oz.)	Bottom row of boxes			Middle row of boxes			Top row of boxes		
		Dead	Living	% kill	Dead	Living	% kill	Dead	Living	% kill
1	10	4237	1	99.98	4450	75	98.34	3484	1240	73.75
2	16.67							545	0	100
4	16.67	3963	0	100	4253	44	98.98	4291	59	98.64
5	20				3010	0	100	4447	7	99.84

The first experiment showed a decreased effectiveness from bottom to top in the chamber. The fumigant evolving from the bottom and the tendency of HCN to rise, at once suggested the need of increased charges. The fourth and fifth experiments, both representing increased charges, show proportionate increases in kill throughout the chamber, the top still being the area of least effectiveness.

The majority of test-bags, being placed deeply within the trash, constituted conditions decidedly prejudiced in favor of conservative results since the greater portion of the beetles in bulk trash crawl out of it into the free space.

This fumigator permits immediate placing of the trash as produced, thus not only preventing dissemination of the beetles pending fumigation but facilitating their destruction by allowing time for them to emerge from the trash and concentrate on edges of boxes and in various corners. Again, one fumigation suffices, and this at night in the absence of operatives. After treatment the trash is already boxed and may be used about the yard in any desired manner. The whole operation fits so evenly into the routine procedure that not more than 15 minutes additional are required per day for such treatment.

The cost of the fumigatorium averages about $35.00. Cost of calcium cyanide flake as used in the fifth experiment amounts to 30 cents per day. Fourteen units of the size mentioned were installed at various raisin plants during November and December, while ten others will be constructed shortly.

II. Protection of Raisins from Infestation during Storage

The handling of trash just reviewed is estimated to destroy from 75 to 85 per cent of the beetles present in stored raisins. The remainder escape during transfer from the storage sheds to and about the stemming machine. Oryzaephilus-infested raisins are no doubt occasionally received from growers, but the greater infestation occurs on the plant premises.

Obviously, then, in heavily infested plants stored fruit needs protection from yard infestation. Again, since a certain hazard of infestation is practically omnipresent, it is none the less desirable to provide such protection as a routine practice. In other words, protection against infestation is preferable to partial destruction of the beetles after they have fed upon and bred in the fruit, because of the resulting shrinkage in weight and the loss of lustre and general fresh appearance.

In this connection the senior author designed a metal arc-barrier and the junior writer suggested a modification which will be termed the angle-barrier. At this writing only the principles embodied and inconclusive results may be reported.

The Arc-barrier

The arc-barrier is made from thin galvanized sheet iron 18 inches in width by rounding the upper 6 inches to form a perfect half-cylinder of a 4-inch diameter. All corners are spliced to preserve the same rounded curve throughout, and all joints are carefully soldered. This device is designed for use around the base of the open storage shed. The shed would first be surrounded by 1 by 12 inch boards set on edge, sunk 4

inches into the ground, and secured to the supports of the shed. The barrier would then be applied exteriorly to this board facing with the over-hanging half-cylinder directed away from the shed and the straight 12-inch metal surface sunk 4 inches into the earth.

The design of this barrier is based upon observations on the habits of Oryzaephilus adults. All of the writers' observations indicate that their locomotion is restricted to crawling, despite their possession of fully-developed wings. Another common tendency is that of crawling upward. Again, they seek areas of lesser intensity of light. Pending the outcome of other experiments their non-flight has been accepted as tentative and experiments with the barriers carried out.

In order to enter stacks so protected, the crawling beetles would pass over three distinct surfaces. The ascent of the vertical surface would be followed successively by the concave and the convex facings of the half-cylinder.

In the first experiment, of 24 hours duration, 6000 beetles were used. Upon liberation at the foot of the vertical surface the majority crawled upward. Later, some which had previously gone downward were observed travelling upward over the supporting apparatus, finally mingling with those on the barrier. The beetles slipped back repeatedly on the vertical surface, only those which crawled with extreme slowness attaining the concave surface. Here a further reduction occurred as they became more directly subjected to the pull of gravity. Among those remaining attached, a marked tendency to come to rest at the zenith of the concave was noted. The progress of those few which advanced toward the over-hanging edge indicated that this portion of travel was even more difficult than the previous way.

During the first four hours of the experiment a total of 7 beetles was noted to have passed the over-hanging edge of the concave. Two of these fell from the convex surface when about two inches above the edge. Another one reached the top of the convex and was returning toward the edge when it also fell. Two others, after wandering about the top of the convex, returned to the concave facing and finally came to rest at its zenith. Two others observed upon the convex surface had disappeared at the next observational period.

The Angle-barrier

This barrier is made from galvanized sheet iron 18 inches in width by bending the upper 6 inches to form a 20-degree angle with the vertical 12-inches. The corners are spliced to preserve the same angle throughout.

Experimental Results

Table 2 shows the number of beetles observed to reach the downward-projecting edge and also the number of beetles found in the raisins placed inside the barriers. The detailed happenings above cited relate to the 7 beetles which reached the edge in experiment number 1 with the arc-barrier.

Table 2.—Results of Laboratory Experiments with Metal Barriers as Protection Against the Saw-toothed Grain Beetle

Type of barrier	Expt. No.	Duration of Expt. (hrs.)	No. beetles used	No. beetles observed to reach edge	No. beetles in raisins inside barrier at end of experiment
Arc	1	24	6000	7	0
Arc	2	24	5000	3	2
Angle	1	24	5000	5	2

The above experiments show that the metal barriers exercised a very considerable retarding effect upon Oryzaephilus adults. Furthermore, the protective values of the barriers seem to lie more in causing the beetles to come to rest in the shadow at the zenith of the concave or angle than in constituting a handicap which cannot be overcome by at least a percentage of them.

Despite the promising results of these laboratory tests the writers quite recognize that the alternate coating of the metal surfaces with moisture and dust or a seasonal variation in the habits of the insect might greatly reduce the effectiveness of the devices. Long-time experiments under actual plant conditions are expected to be installed shortly.

THE LIFE HISTORY OF *DIABROTICA VITTATA* FABR. IN IOWA (*CHRYSOMELIDAE, COLEOPTERA*)

By Harvey L. Sweetman, *University of Minnesota*[1]

Abstract

Two generations of the striped cucumber beetle, *Diabrotica vittata* Fabr. were found in Iowa. The first equired 37 days and the second 51 for development. Females of the first averaged 225 eggs and the second 337. The over-wintering stage in this state has not been discovered and any extensive recommendations for biological methods of control must await this knowledge.

The striped cucumber beetle, *Diabrotica vittata* Fabr., has been known as the most destructive of all cucurbit insects in parts of the United States and Canada since Gaylord first recorded its ravages in 1843. In

[1]This work was done at the Iowa Agricultural Experiment Station.

the curcurbit growing sections of Iowa its annual presence incurs serious loss to the commercial and home grower. The damage from the well-known forms of attack by the beetle and its larvae is augmented by its agency in the spread of vine diseases. The development of methods of artificial and biological control will be greatly aided by a thorough understanding of its life history and this work was entered upon with that point in view. While such studies have been made for both the eastern and southern regions of the United States, none that is complete has been published for the Middle West.

In 1924 vine crops were backward in their growth because of the cold,

TABLE 1.—EGG LAYING RECORDS FOR THE SECOND GENERATION

Cage No.	Date caught	Days lived	Total eggs laid	Eggs not laid	Cage No.	Date caught	Days lived	Total eggs laid	Eggs not laid
1	June 14	4	17		29	June 17	30	517	24
2	" 14	10	98		30	" 17	6	26	
3	" 14	55	327		31	" 17	42	541	49
4	" 14	30	296	0	32	" 17	38	184	41
5	" 14	7	75		33	" 17	35	410	0
6	" 14	25	237	1	34	" 17	30	585	0
7	" 15	8	1	118	35	" 17	35	383	50
8	" 15	3	0		36	" 17	31	67	233
9	" 15	14	175		37	" 17	39	459	0
10	" 15	13	66		38	" 17	48	627	0
11	" 15	20	199		39	" 17	2	0	
12	" 15	15	151		40	" 17	41	375	67
13	" 15	15	142		41	" 17	25	231	36
14	" 15	13	24		42	" 17	12	61	
15	" 15	23	163	0	43	" 17	15	90	80
16	" 17	18	212		44	" 17	50	282	66
17	" 17	44	372	33	45	" 17	20	117	72
18	" 17	3	0		46	" 17	28	182	46
19	" 17	33	287	16	47	" 17	36	369	0
20	" 17	31	288	7	48	" 17	30	33	69
21	" 17	26	255	51	49	" 17	56	909	0
22	" 17	19	79	25	50	" 17	77	53	
23	" 17	32	231	0	51	" 17	19	104	150
24	" 17	19	160	250	52	" 17	26	135	38
25	" 17	28	191	3	53	" 17	51	861	0
26	" 17	13	129		54	" 17	23	103	0
27	" 17	20	102		55	" 17	14	135	
28	" 17	7	12		56	" 17	29	52	196

Ave. No. eggs laid by one beetle	225
Min. No. eggs laid by one beetle	0
Max. No. eggs laid by one beetle	909
Ave. No. eggs not laid (found by dissection)	49

rainy weather in the early spring and summer. Melons were a failure, cucumbers yielded poorly, and pumpkins and squashes were late in development. The climatic conditions and poor plant growth undoubtedly affected insect activities. Throughout the season field observations were carried on in conjunction with the insectary studies.

Life History

The females usually place the eggs in cracks and crevices in the soil within a few inches of cucurbit roots, but occasionally they are laid on the surface of the soil and on the stems of the plants. For these experiments adults were collected in the field and placed in cages. Subsequent egg laying together with date of capture is given for 56 females of the second generation in Table 1.

The total number of eggs laid for the season varied from 0 to 909 with an average of 225. But a simple inspection of the distribution shows that this average does not represent the number of eggs laid by the typical beetle for 64 per cent of the cases fall below it. Possible laying previous to collection on the part of some of the females may explain this skewness.

When beetles were dissected after death from 0 to 250 or an average of 49 eggs were found which may or may not have been laid had conditions been natural. The highest number of eggs laid by a single insect in a 24 hour period was 85. One female lived 56 days (until August 11)

Table 2.—Incubation Periods of the Eggs Laid by the Second Generation

Date of laying	Average incubation period	Date of laying	Average incubation period	Date of laying	Average incubation period
June 22	12	July 6	7	July 21	8
" 23	10	" 7	7	" 22	7
" 24	9	" 8	7	" 23	7
" 25	11	" 9	7	" 24	6.5
" 26	no hatch	" 10	7	" 25	6.5
" 27	11	" 11	7	" 26	6.5
" 28	9.5	" 12	7.5	" 27	7
" 29	11	" 13	7.5	" 28	7
" 30	10	" 14	9	" 29	6
July 1	no hatch	" 15	9	" 30	6.5
" 2	no hatch	" 16	9	" 31	6
" 3	8.5	" 18	7	Aug. 5	9
" 4	8	" 19	8	" 6	10
" 5	7.5	" 20	8	" 7	10
				" 9	10

Ave. 8 days
Min. 4 days
Max. 12 days

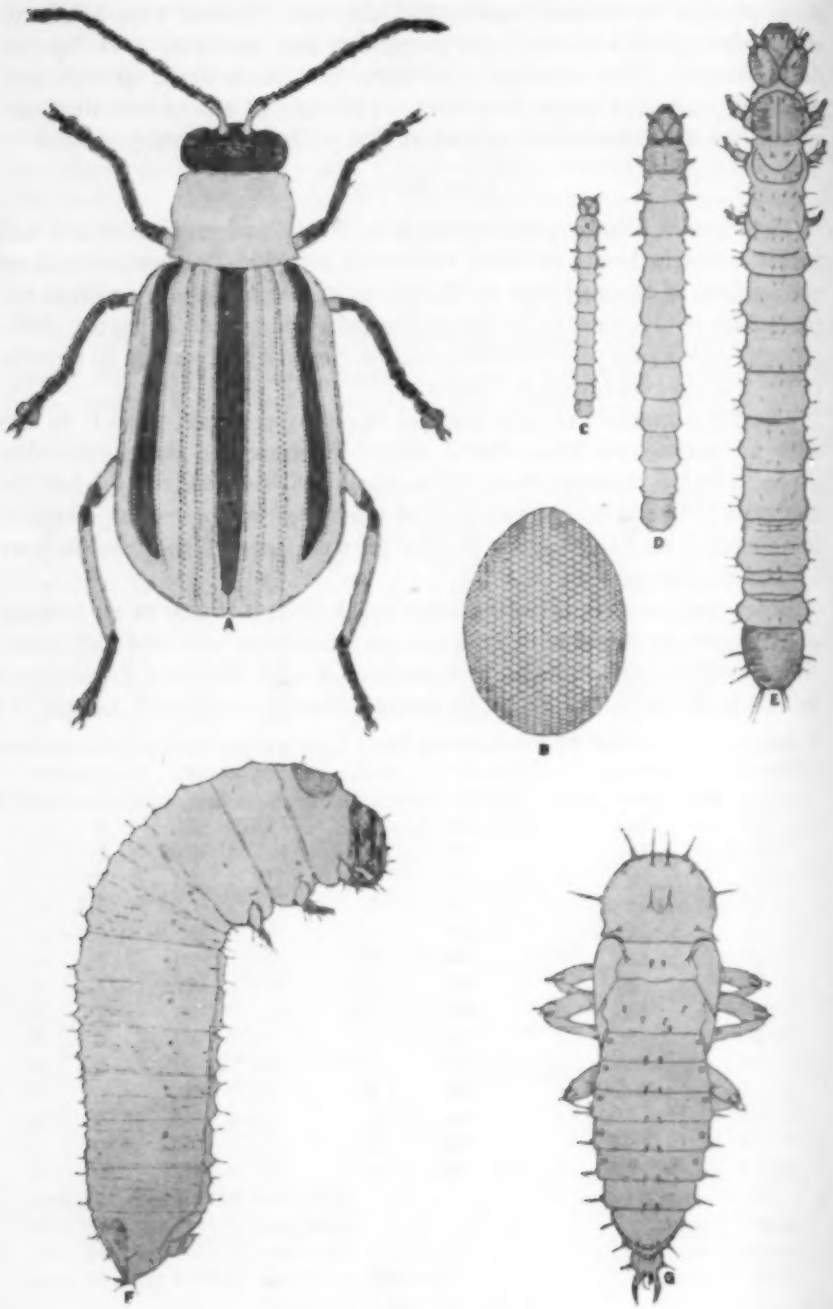

FIG. 23.—*Diabrotica vittata: A* adult, *B* egg, *C*, *D*, *E* first, second and third larval instars respectively; all enlarged (Original).

and produced eggs up to the day of death. Some males caught in the spring and kept in the insectary lived well into October.

The incubation periods for the eggs laid by the second generation are recorded in Table 2.

The shortest incubation period was 4 days and the longest 12 with an average of 8. The hatching interval for a mass of eggs laid on the same day often extended over 2 or 3 days, usually the majority hatching on the first. Incubation was greatly shortened by warm weather.

The larvae of the striped cucumber beetle are naturally underground feeders but will feed above ground on stems and fruit where such come in contact with the soil. They habitually avoid light and when feeding above ground keep in the darkness as much as possible. Upon liberation from the egg the larvae begin a hurried but unguided search for food. They will live in moist soil for about 2 days without food, but mortality is high after 12 hours even when food is found. Probably many larvae succumb a few hours after hatching since in the insectary they crawled away from food as often as toward it. Even when placed upon roots they sometimes left and showed no inclination to return although other larvae were feeding there. The presence of light may have caused part of this unrest.

Table 4 shows the length of the stages in the life history of the larva until it emerges as an adult. (See page 801)

The average, minimum, and maximum number of days spent in each period is indicated. The total average time required from laying of egg to emergence of adult for this generation was about 37 days. There was considerable variation in the length of each stage among larvae that hatched the same day. During this year it is seen that adults of the first generation were emerging in increasing numbers from July 20 on. This was confirmed by field observations since the first beetle of this generation was noticed there July 19.

A more detailed study of the metamorphosis of 16 larvae was made to determine the number of instars. Three were found to occur. These instars were recognized by the collection of cast skins and by the following measurements:

HEAD MEASUREMENTS OF LARVAE

Stage of development	Head length in mm.			Head width in mm.		
	Max.	Min.	Ave.	Max.	Min.	Ave.
First instar	0.30	0.25	0.287	0.25	0.20	0.237
Second instar	0.35	0.30	0.328	0.30	0.25	0.278
Third instar	0.55	0.50	0.51	0.45	0.38	0.406

PYGIDIUM SPINE LENGTH

First instar	Hardly visible (medium power binocular)
Second instar	about .03 mm.
Third instar	.09 mm.

The records of the individual instars with the maximum, minimum, and average number of days in each stadium are shown in Table 3.

TABLE 3. INSTAR RECORDS OF THE FIRST GENERATION LARVAE

Date larva emerged	Stadia-days 1st	2nd	3rd Feeding	3rd Prepupal	Days pupal period	Days adult remained in cell	Total number days	Date adult emerged
July 3	4	4	6	3	d			
" 3	5	4	6	3 d				
" 3	4	3	7	5	6	1	26	July 29
" 3	4	4	6			(11)	25	" 28
" 3		(8)	6	3	10 d			
" 3	4	4	7	4	d			
" 25	4	4	4	7	8	2	29	Aug. 23
" 25	4	3	7	6		(9)	29	" 23
" 25	4	4	3	7	9	2	29	" 23
" 25	4	4	4	7	8 d			
" 25	4	4	4	6	9	2	29	" 23
" 25	4	4	5	6	8	2	29	" 23
" 25	4	4	4	6	9	2	29	" 23
" 25	4	5	4		(16)	1	30	" 24
" 25	5	4	3	6	9	2	29	" 23
" 28		(7)	5	8	7 d			
Min.	4	3	9					
Ave.	4	4	10.5					
Max.	5	5	13					

d—died.

Previous to entering the prepupal state the mature larva sought rather moist soil and rounded out a delicate, oblong, earthen cell for the prepupal and pupal life. Extreme drying of the soil about the cell did not injure the larva or pupa. A few hours following the formation of the cell the larva became inactive, contracted, and thickened. Just prior to the third moult a microscopic examination showed the anterior end of the larva, or larval skin as it may properly be called, filled with a more or less clear liquid and the immature pupa within freed from the skin at this point. The larval skin then split on the dorsal side of the thoracic region, and the pupa emerged through the opening, separating itself from the old covering by twisting the abdomen which is freely movable.

Upon emergence the beetles sought food immediately. They spent

TABLE 4.—THE LARVAL AND PUPAL STAGES OF THE FIRST GENERATION

Date larva emerged	Days in feeding period	Days in prepupal period	Days in pupal period	Days adult remained in cell	Total number of days	Date adult emerged
June 24	24	4	7	1	36	July 30
" 24	19	5	8	1	33	" 26
" 24	20	4	7	1	32	" 25
" 24	24	5	6	1	36	" 30
" 24		(19)	7	1	27	" 20
" 28	16	6	6	1	29	" 25
" 28	16	6	6	1	29	" 25
July 2	12	5	6	1	24	" 26
" 3	16	5	6	1	28	" 31
" 3	14	4	7	1	26	" 29
" 3	14	5	6	1	26	" 29
" 3	15	4	6	2	27	" 30
" 3	14	4	7	1	26	" 29
" 3	16	4	6	1	27	" 30
" 3	14	4	7	1	26	" 29
" 3	14	4	7	0	25	" 28
" 3	13	4	8	0	25	" 28
" 3	16	4	6	1	27	" 30
" 3	13	4	7	0	24	" 27
" 3	14	5	6	1	26	" 29
" 3	14			(11)	25	" 28
" 6	17	4	7	1	29	Aug. 4
" 8	15	4	8	1	28	" 5
" 8	15	4	8	2	29	" 6
" 11	16	4	8	1	32	" 14
" 14					30	" 13
" 16					27	" 12
" 16					31	" 16
" 17					29	" 15
" 17					29	" 15
" 17					30	" 16
" 17					30	" 16
" 18					36	" 23
" 18					37	" 24
" 18					37	" 24
" 25	12	7	8	2	29	" 23
" 25	14	6		(9)	29	" 23
" 25	11	7	9	2	29	" 23
" 25	12	6	9	2	29	" 23
" 25	13	6	8	2	29	" 23
" 25	12	6	9	2	29	" 23
" 25	13		(10)	1	30	" 24
" 25	12	6	9	2	29	" 23
" 31					30	" 30
" 31					31	" 31
" 31					31	" 31
" 31	16	6	6	2	30	" 30
Aug. 1	14	6	7	1	28	" 29
" 2	20	5	6	2	33	Sept. 4
" 2	18	3	6	2	29	Aug. 31
" 4					33	Sept. 6
" 4					33	" 6
" 16					40	" 24
" 16					40	" 24
" 16					40	" 24
Min.	11	4	6	0	24	
Max.	24	7	9	2	40	
Ave.	15	4.7	7	1	29	

TABLE 5.—EGG LAYING RECORDS OF THE FIRST GENERATION

Cage No.	Date emerged	Pre-laying period	Days lived	Total eggs laid	Cage No.	Date emerged	Pre-laying period	Days lived	Total eggs laid
1	July 22	8	58	1018	11	July 29	8	40	137
2	" 26	22	44	511	12	" 30	15	27	247
3	" 26	20	25	3	13	" 30	17	42	437
4	" 27	19	47	453	14	" 30	21	32	6
5	" 27	19	50	406	15	" 30	20	64 c	127
6	" 28	19	32	2	16	Aug. 3	13	62	295
7	" 28	11	47	729	17	" 8	12	59 c	226
8	" 29	7	47	616	18	" 12	17	56 c	223
9	" 29	10	69 c	441	19	" 16	7	48 c	7
10	" 29	7	22 e	157					
Min. No. eggs		2							
Ave. No. eggs		327							
Max. No. eggs		1018							

c—cage closed
e—beetle escaped

TABLE 6.—INCUBATION RECORDS FOR THE EGGS LAID BY THE FIRST GENERATION

Date of laying	Average incubation period	Date of laying	Average incubation period	Date of laying	Average incubation period
July 31	8	Aug. 20	8	Aug. 28	no hatch
Aug. 1	6.5	" 21	6	" 28	8
" 3	8	" 21	6	" 29	no hatch
" 6	9	" 21	no hatch	" 29	9
" 6	9	" 21	7	" 30	no hatch
" 7	10	" 22	6	" 30	no hatch
" 9	10	" 22	7	" 31	no hatch
" 9	11	" 22	7	Sept. 1	12
" 12	10	" 23	7	" 2	no hatch
" 12	11	" 23	7	" 3	no hatch
" 13	10	" 23	7	" 4	no hatch
" 13	9.5	" 24	6	" 4	11
" 14	no hatch	" 24	6	" 5	11
" 15	8	" 24	6	" 6	no hatch
" 15	9	" 24	7	" 6	no hatch
" 16	9	" 25	5	" 7	15
" 17	9	" 25	6	" 8	12.5
" 18	7	" 26	5	" 9	13
" 18	9	" 26	5	" 14	no hatch
" 19	8	" 26	6	" 14	no hatch
" 20	7	" 27	7	" 27	no hatch
" 20	7	" 27	7	" 27	no hatch
		" 28	no hatch	Oct. 2	no hatch
Min. No. days	5				
Ave. No. days	8				
Max. No. days	13				

an average preoviposition period of 15 days during which frequent copulations were observed. Table 5 gives the records of egg laying for 19 beetles of this generation with the average, maximum, and minimum records for the season. All three of these figures exceeded those of the second generation. The greatest number of eggs laid by one individual in 24 hours was 123, but it was not uncommon for a record for that length of time to be over 100.

The incubation records of the eggs laid by the first generation together with the average and extremes are given in Table 6. Again masses of eggs laid the same day often hatched after varying intervals but in general higher temperatures decidedly shortened the time.

Table 7 shows the duration of the stages in the metamorphosis of the second generation larvae.

The minimum, average, and maximum number of days in each period is indicated. The cool weather during August, September, and October lengthened the feeding period of the larvae and about doubled the time spent in the prepupal period. Likewise the length of the pupal period was twice that of the first generation. When the average time for incubation, 8 days, is added to the average time spent previous to the emergence of the adult, 43 days, it is found that a total of 51 days was necessary to produce an adult of this generation. This was two weeks more than the average for the first generation. There was considerable variation in the length of each stage among larvae that hatched on the same day.

During this year it is seen that adults of the second generation were emerging from September 15 to October 27. Field observations found this emergence continued until November 10. Mature larvae and pupae were present in the laboratory cages after October 27 and at least one pupa was alive as late as December 4 but none survived the winter. Most of the second generation appeared after the first frost, but cucurbit vines were not destroyed until the heavy frost on October 20.

In the laboratory about 50 per cent of the fall emergence produced eggs and all but 5 out of the 18 which laid, died before the studies were closed on October 7. These, with the remaining 50 per cent, were living and vigorous until November 21. After the first heavy freeze on that date only dead beetles were found in both field and insectary. Furthermore, feeding was continuous throughout the day previous indicating that no preparations for wintering were made. Many authors state that the beetles hibernate in the northern states in rubbish and weeds that afford protection. Field and insectary observations until May 1925

TABLE 7.—THE LARVAL AND PUPAL STAGES OF THE SECOND GENERATION

Date larva emerged	Days in feeding period	Days in prepupal period	Days in pupal period	Days adult remained in cell	Total number days	Date adult emerged
Aug. 16					36	Sept. 21
" 16					38	" 23
" 16					38	" 23
" 16					38	" 23
" 20	10	7	10	3	30	" 19
" 20	15	11	9	3	38	" 27
" 22					43	Oct. 4
" 22					36	Sept. 27
" 22					41	Oct. 2
" 22					41	" 2
" 22					43	" 4
" 22					43	" 4
" 23					40	" 2
" 23					44	" 6
" 24	20	8	15	5	48	" 11
" 24	17	8	16	2	43	" 6
" 24	20	6	15	5	46	" 9
" 24		(28)	18	2	48	" 11
" 24					37	Sept. 30
" 24					41	Oct. 4
" 24					43	" 6
" 24					43	" 6
" 24					44	" 7
" 26	19	9	16	2	46	" 11
" 26	18	8	15	5	46	" 11
" 26	18	8	18	2	46	" 11
" 27					38	" 4
" 27					38	" 4
" 27					38	" 4
" 28	18	10	16	2	46	" 13
" 28	19	11	16	3	49	" 16
" 30	17	9	18	3	47	" 16
Sept. 3	20	14	13	5	52	" 25
" 3	20	14	13	7	54	" 27
" 3	20		(28)	6	54	" 27
None emerged after October 27.						
Min.	10	6	9	2	30	
Ave.	18	9	15	4	43	
Max.	20	14	18	7	54	

in connection with this work have failed to lead to the discovery of the over-wintering stage in this area, although the first live beetles in 1925 were collected April 22. In the south no true quiescent state is reached but the adults become inactive during cold days.

The fact that a large percentage of the second generation beetles emerged after the fruit was harvested suggests the possibility of biological control of the striped cucumber beetle in Iowa. Immediate destruction or removal of the vines and waste and immature fruit would deprive the developing larvae of their food supply and prevent them from reaching maturity. Plowing would only partially cover the vines and it is also possible that the stems might function as channels of escape from the lower depths of soil.

After the clean-up campaign, deep plowing (6 inches or more) followed by disking or harrowing to fill up the crevices would place the pupae so far below the surface that the newly transformed adults could not emerge. These practices would prevent the emergence of most of the second generation and destroy many in the immature stages so that the number over-wintering in any form would be decreased considerably.

The place of emphasis of this type of control must await determination of the hibernation stage.

Food Plants

The adult *D. vittata* uses a great variety of plants for food. It is decidedly a flower feeder, and was observed working upon the blossoms of many species, both cultivated and wild, throughout the season. All portions of the flowers are eaten. Observations in Iowa include the following food plants on which a part other than the flower is attacked: pumpkin, squash, cucumber, cantaloupe, watermelon, wild cucumber (*Echinocystis lobata*) and leaves, silks, and unripe kernels of corn; in addition Missouri gourd (*Cucurbita foetidissima*) in eastern Colorado. Other authors include the leaves and pods of beans and peas, leaves and fruit of apple trees, *Aster puniceous*, *Solidago altissima*, and *Ambrosia trifida* (Chittenden, 1923); okra, potato, and citrus trees (Watson, 1916, 1918); horse chestnut, elm, and syringa (Headlee, 1908a).

Proportions of Sexes

In order to estimate the proportion of males to females records were kept of 2000 individuals caught over a period of 30 days during June and July. The males were slightly in the minority, totaling 46 per cent. As a single male is capable of fertilizing several females no detriment would result to the species because of extra females.

Frequency of Copulation

Frequent copulations were observed both in the field and insectary, and it was thought advisable to determine if they were necessary to

maintain fertilization. Two females and a male from the first generation and a male from the second generation were used. Female No. 1 (Table 5) was caged with a newly emerged male that died when 7 days old, from July 25 to August 1, during which time she laid 49 eggs. After August 1 oviposition continued until September 14 when a total of 1018 was reached. None of the 149 eggs laid after August 27 hatched, but this was true of the others (See Table 6). Female No. 9 (Table 5) was with a second generation male, which had been previously mated with others, from August 1 to 20, during which time 86 eggs were deposited. After August 20 laying continued until September 29 when a total of 355 eggs was reached. Again none of the 195 laid after August 26 hatched. This evidence indicates that a single copulation or at least copulations repeated during a very short portion of the laying season are all that are necessary to maintain fertility.

Cross Copulation

A rather unusual phenomenon is the copulation of males of *D. vittata* with the females of *D. 12-punctata*, both in the field and insectary. A number of offspring of one female so mated were reared but no unusual forms resulted. Since *D. 12-punctata* females are probably normally fertilized in the fall, the chance of cross-fertilization is greatly reduced. However, color variations of both species were noticed in the field, one specimen in particular having the dorsal markings of *D. vittata* and the ventral markings of *D. 12-punctata*. Headlee (1908b) noted similar attempts at copulation and Sirrine (1899) found striped males attached to spotted females.

Summary

The striped cucumber beetle, *D. vittata* is a pest of considerable economic importance in the cucurbit growing sections of Iowa but no complete records of its life history in this area have yet been published. Field and insectary studies were carried on at Ames throughout 1924, a year with a cold, wet, growing season, and into the spring of 1925.

Two generations were found. Captured beetles of the second generation laid an average of 225 eggs which hatched in an average of 8 days. The larvae fed about 15 days and spent 5 in the prepupal period. Three instars were determined. After an additional interval of one week as pupae, transformation to adults took place, the imagines usually emerging in about one day. These beetles copulated immediately and began laying after a mean interval of 15 days. For this generation the average number of eggs laid was 327; the average number of days for incubation, 8; feeding, 18; prepupa, 9; pupa, 15; and after transforma-

tion and before emergence, 4. A total average of 51 days was required from egg to adult for this generation which was two weeks more than that for the first. The hibernation stage has not been determined, but since a large per cent of the second generation emerges after the fruit is harvested, clean-up and fall plowing are suggested as means of biological control.

LITERATURE CITED

CHITTENDEN, F. H.
1899 Notes on the striped cucumber beetle. U. S. Dept. Agr., Division of Entomology Bul. 19 new series; 48.
1923 The striped cucumber beetle and how to control it. U. S. Dept. Agr., Farmers' Bul. 1322:1–16.
GAYLORD, W. A.
1843 Transactions of the New York State Agricultural Society. (Reference on p. 127).
HEADLEE, T. J.
1908a New Hampshire Agr. Exp. Sta. Rpt. 29:499.
1908b Life history of the striped cucumber beetle with a brief account of some experiments for its control. Jour. Ec. Ent. I:203–207.
SIRRINE, F. A.
1899 Combating the striped cucumber beetle on cucumbers. N. Y. State Agr. Exp. Sta. Bul. 158:1–32.
WATSON, J. R.
1916 Fla. Agr. Exp. Sta. Rpt., 1915. (Reference on p. 64R).
1918 Insects of a citrus grove. Fla. Agr. Exp. Sta. Bul. 148:258–9.

STUDIES ON *NICOTIANA RUSTICA* AS A SOURCE OF A NICOTINE FOR INSECT CONTROL[1,2]

By D. E. HALEY, OTTO OLSON[3] and F. L. FOLLWEILER

ABSTRACT

This investigation had for its purpose the testing of the rate of volatilization of nicotine from ground *Nicotiana rustica* (a high nicotine tobacco) in order to ascertain whether or not this type of tobacco could be used as an insecticidal dust.

The ground tobacco was used alone, or with other materials.

The rate of nicotine evolution was measured by the death rate or suspended animation of cabbage aphids (*Aphis brassicae* Linnaeus) and other soft-bodied insects.

As a result of these studies the following conclusions seem justified:

[1]Contribution No. 17 from the Department of Agricultural and Biological Chemistry, The Pennsylvania State College.

[2]This investigation was conducted in cooperation with Dr. W. W. Garner of the U. S. Bureau of Plant Industry, Office of Tobacco Investigations and Professor F. D. Gardner of The Pennsylvania State College.

[3]Mr. Olson's part in this work had to do with the production of tobacco material.

(1) The ground tobacco, when used alone, with water or with basic lime compounds was not efficient as an insecticide in the control of aphids.

(2) If sufficient quantities of basic materials were mixed with the ground tobacco, it was found that the addition of water resulted in the evolution of nicotine, the rate of evolution depending in a large measure on the amount of water added.

(3) A mixture containing 5 parts of tobacco, 5 parts of hydrated lime and 3 parts of water proved to be very efficient as an insecticide under laboratory and field conditions. Notwithstanding the relatively large amount of water present, it was found that such a mixture could be applied to vegetation by the use of power blowers and with no especial difficulty.

(4) Mixtures of the ground tobacco, water and basic lime compounds could be kept in sealed containers for a relatively long period of time with no apparent loss of toxicity.

(5) These experiments warrant that some consideration be given to the possibility of cultivating *Nicotiana rustica* for its nicotine content alone and to utilize it in the form of an insecticidal dust.

Introduction

Nicotine has proven to be an extremely valuable material for the control of soft-bodied insects. Indeed, at the present time no satisfactory substitute for it has been obtained. For a number of years, and even at the present time, nicotine has been successfully used in solution form. Recently, however, there has been a tendency to use dusts containing free nicotine. On the whole, these dusts have probably proven more satisfactory than nicotine solutions. At any rate, since dusting has been practiced, an increased demand for nicotine, as an insecticide, has become apparent.

Tobacco plants constitute the sole source of nicotine, but, as yet, these plants have never been successfully grown for nicotine production alone. As a matter of fact, the present supply of nicotine is limited to those parts of the tobacco plant containing the least amount of nicotine, the leaves, containing greater quantities than the stalk and stems, are almost wholly used in the manufacture of cigars, cigarettes, smoking and chewing tobaccos.

Anticipating the probable need of augmenting the natural supply of nicotine, Dr. W. W. Garner of the U. S. Bureau of Plant Industry planned the development of high nicotine tobaccos with the view of cultivating these plants for their nicotine content alone. Olson (4), who had charge of the field work, states that of all the high-nicotine strains studied, *Nicotiana rustica* was the one selected for subsequent development. At the present time, owing to processes of breeding, fertilization, etc., the entire dry weight of plants, when mature, will probably contain more than five per cent of nicotine. Studies dealing with the utilization of the nicotine from these plants have since been reported (1).

Object of These Investigations

The object of these investigations was to ascertain whether or not the nicotine of *Nicotiana rustica* plants could be directly utilized for insect control, thereby eliminating processes of extraction and incidentally lowering the cost of the insecticide. If this became possible it was thought that the time had probably arrived for the growing of this tobacco for its nicotine content alone.

Results of Previous Investigations

Coarsely ground tobacco dust, according to Smith (5), was ineffective as an insecticide when applied to dry plants but had some effect on moist plants. Finely ground tobacco was found much more effective under the same conditions. Smith also found that tobacco dust put into the soil was an effective means of combating the peach louse. It was later found by the same investigator that the house fly succumbed very readily when brought into contact with the dust.

Weed (9) states that the dusting of lettuce, roses and other plants with tobacco dust destroyed the plant lice with which they were infected.

Experiments conducted by Stedman (7) showed that applications of tobacco dust were effective in preventing depredations by the woolly aphis of the apple.

Smith (6) mixed equal quantities of tobacco dust with equal parts of hydrated lime and applied this mixture to trees infested with aphids but found that the beneficial effect was hardly noticeable. Further investigations, however, showed that the tobacco dust used contained less than one per cent of nicotine.

MacLeod and Harman (3) found that in general the addition of hydrated lime to tobacco dust resulted in decreasing its insecticidal efficiency, and this loss in toxicity increased proportionally with the increase in amount of lime added. It was found that a tobacco dust diluted with ten per cent lime hydrate was not as effective as pure tobacco dust but was of more value than a mixture containing twenty-five per cent hydrated lime. Thatcher and Streeter (8) previously had shown, however, that hydrated lime liberated nicotine from dry tobacco dust.

On the whole, it is apparent that tobacco dust, used alone, or in combination with certain carriers has hardly proved as effective as nicotine sulfate-lime dusts, such as are mentioned by Smith (6), MacLeod and Harman (3), Thatcher and Streeter (8), Headlee and Rudolfs (2), and many others.

Experimental

Preliminary experiments showed that dry tobacco dust was practically worthless as an insecticide. The addition of water, however, showed that nicotine was liberated at an extremely slow rate, not sufficient to make it effective for insect control. Recognizing the fact that the reaction of nicotine is somewhat similar to that of ammonia and that it forms, for the most part, rather stable salts in the plant, it was thought that a basic material such as hydrated lime could be used with the tobacco, provided that sufficient water was present to extract the nicotine from the plant cells, to dissolve the lime compound and to aid the chemical reaction. It was found that dry lime compounds had apparently no effect on the volatilization of nicotine.

Plan of Experimental Work

The plan of these experiments, therefore, was to take certain mixtures of *Nicotiana rustica* dusts, basic calcium compounds and water and to ascertain the rate of nicotine evolution by a study of the death rate of cabbage aphids under suitable conditions. The reason for using these calcium compounds was that they are easily obtainable, chemically effective and comparatively harmless to plants.

Methods Used in Experimental Work

The materials required for the mixtures were weighed separately and transferred to tin-foil containers, 7 cm. in diameter with a depth of 2.6 cm. and of approximately 85 cc. capacity. The required amount of distilled water was then added with a pipette, the container and contents were weighed and the whole of the material carefully mixed. The material was then evenly distributed over the bottom of the dish and covered with a circular piece of copper gauze inserted into the container about a centimeter above the dust mixture and allowed to stand 20 minutes. The insects were carefully transferred to the gauze with a fine camel's hair brush from the cabbage plants on which they had rested while in the field. The container was then placed on a Petri dish 9.5 cm. in diameter and 1.75 cm. in height, on which it rested firmly. The container was then covered over with an inverted, thin glass, flanged top, titration beaker of 460 cc. capacity, 14.5 cm. in height, having an internal diameter of 7 cm. This arrangement proved to be practically air-tight. A sufficient number of insects being placed on the gauze, the beaker was quickly placed over the container and the exact time noted. When no further life was observed, which could be readily

ascertained by the aid of a reading glass or of a special microscope and a micro lamp, the time was taken and the interval from the time of placing of the beaker over the mixture until the complete loss of animation of the insects was recorded as the death rate. The insects were then counted and their number recorded. It was found that fifty or more insects always gave consistent results. After every experiment the beakers were thoroughly washed with distilled water and dried. New dishes were used for every experiment, while the copper gauze was burned off, washed in distilled water and dried. All experiments were conducted in a room free of draughts, and of fairly constant temperature. Duplicate, and in some cases triplicate determinations were generally made.

After the death rate was recorded for the first period, the tin-foil containers were placed in the open and allowed to stand until the following period. In cases where the mixture was allowed to stand for 24, 48 or 72 hours, sufficient water was added in each case to bring the mixture back to its original moisture content. Experiments showed that the addition of water at this point profoundly increased the volatilization of nicotine, indicating that there must be a relationship between the vaporization of water and the volatilization of nicotine. The average death rate of the insects as established by this method for each mixture served as an index of the insecticidal efficiency of the dust under consideration. In all likelihood a small amount of ammonia is probably evolved in connection with the volatilization of nicotine, but for all practical purposes this can be ignored as it would probably only tend to contribute to the toxicity of the mixture.

Materials Used in Experiments

The materials used in these experiments were ground samples of entire *Nicotiana rustica* plants (40 mesh), containing different quantities of nicotine as determined by analysis. The nicotine content was generally fairly low as the plants were harvested and dried in a somewhat immature condition. Commercial hydrated lime and calcium oxide ground so as to pass through a sieve containing 100 mesh to the linear inch were used. Distilled water was used in every case.

Presentation of Results

Experiment 1

A study of the effects of various combinations of *Nicotiana rustica* dust (4.57% Nicotine), water, and hydrated lime upon the volatilization of nicotine as measured by the death rate of cabbage aphids (*Aphis brassicae* Linnaeus).[4] Temperature 25.5°C.

[4]The number of insects used in all experiments was approximately 75.

TABLE 1

Composition of mixture			Death rate after various periods			
Quantity of Tobacco	Quantity of Hydrated Lime	Quantity of Water	20 minutes	24 hours	48 hours	72 hours
gm.	gm.	cc.	min.	min.	min.	min.
4	6	1	6.5	11.2	13.5	15.5
4	6	2	5.5	10.5	12.4	15.3
4	6	3	5.2	10.3	12.1	15.0
4	6	4	5.8	10.4	12.3	15.1
4	6	5	6.8	10.6	12.6	15.2
4	6	6	7.2	10.9	12.8	15.4

TABLE 2

Composition of mixture			Death rate after various periods			
Quantity of Tobacco	Quantity of Hydrated Lime	Quantity of Water	20 minutes	24 hours	48 hours	72 hours
gm.	gm.	cc.	min.	min.	min.	min.
5	5	1	4.5	9.2	13.5	16.0
5	5	2	3.5	8.5	13.2	15.8
5	5	3	3.0	8.4	13.4	15.7
5	5	4	3.25	8.2	13.3	15.9
5	5	5	5.2	8.4	13.1	16.2
5	5	6	5.8	8.6	13.2	16.5

TABLE 3

Composition of mixture			Death rate after various periods			
Quantity of Tobacco	Quantity of Hydrated Lime	Quantity of Water	20 minutes	24 hours	48 hours	72 hours
gm.	gm.	cc.	min.	min.	min.	min.
6	4	1	5.8	6.2	17.8	17.9
6	4	2	5.5	7.0	16.8	17.8
6	4	3	4.5	6.9	16.4	17.5
6	4	4	3.75	7.0	16.0	17.1
6	4	5	4.0	7.5	16.1	17.2
6	4	6	4.4	8.5	16.2	17.4

TABLE 4

Composition of mixture			Death rate after various periods			
Quantity of Tobacco	Quantity of Hydrated Lime	Quantity of Water	20 minutes	24 hours	48 hours	72 hours
gm.	gm.	cc.	min.	min.	min.	min.
7	3	1	7.0	8.5	8.5	9.0
7	3	2	5.0	8.2	8.0	9.0
7	3	3	3.0	4.5	7.0	8.75
7	3	4	3.5	7.5	8.5	9.2
7	3	5	4.0	7.25	7.5	10.5
7	3	6	4.0	6.5	11.0	11.5

TABLE 5

Composition of mixture			Death rate after various periods			
Quantity of Tobacco	Quantity of Hydrated Lime	Quantity of Water	20 minutes	24 hours	48 hours	72 hours
gm.	gm.	cc.	min.	min.	min.	min.
8	2	1	10.0	10.0	10.5	11.0
8	2	2	5.5	6.5	7.0	8.0
8	2	3	3.0	7.0	7.2	8.5
8	2	4	3.0	7.1	7.5	8.6
8	2	5	3.0	7.0	8.0	9.0
8	2	6	2.5	10.0	11.0	12.0

EXPERIMENT II

A study of the effect of various combinations of *Nicotiana rustica* dust (4.57% nicotine), water, and calcium oxide upon the volatilization of nicotine as measured by the death rate of cabbage aphids (*Aphis brassicae* Linnaeus). Temperature 25.5°C.

TABLE 6

Composition of mixture			Death rate after various periods			
Quantity of Tobacco	Quantity of Calcium Oxide	Quantity of Water	20 minutes	24 hours	48 hours	72 hours
gm.	gm.	cc.	min.	min.	min.	min.
4	6	1	8.0	14.0	14.6	15.8
4	6	2	7.2	13.4	14.2	15.2
4	6	3	6.8	13.2	14.4	15.0
4	6	4	5.0	13.0	14.1	15.2
4	6	5	6.8	13.3	14.2	15.5
4	6	6	7.0	13.6	14.4	15.4

TABLE 7

Composition of mixture			Death rate after various periods			
Quantity of Tobacco	Quantity of Calcium Oxide	Quantity of Water	20 minutes	24 hours	48 hours	72 hours
gm.	gm.	cc.	min.	min.	min.	min.
5	5	1	5.9	13.8	14.5	16.7
5	5	2	4.6	14.1	15.0	16.8
5	5	3	4.0	13.9	15.5	16.9
5	5	4	4.2	14.0	15.6	16.7
5	5	5	4.5	14.1	16.0	17.1
5	5	6	4.7	14.1	16.2	17.2

TABLE 8

Composition of mixture			Death rate after various periods			
Quantity of Tobacco	Quantity of Calcium Oxide	Quantity of Water	20 minutes	24 hours	48 hours	72 hours
gm.	gm.	cc.	min.	min.	min.	min.
6	4	1	7.0	10.5	13.5	15.2
6	4	2	3.8	9.5	12.3	14.8
6	4	3	3.5	9.7	12.0	14.5
6	4	4	3.4	9.75	11.8	14.6
6	4	5	3.5	10.2	12.2	14.8
6	4	6	4.0	11.5	12.5	15.0

TABLE 9

Composition of mixture			Death rate after various periods			
Quantity of Tobacco	Quantity of Calcium Oxide	Quantity of Water	20 minutes	24 hours	48 hours	72 hours
gm.	gm.	cc.	min.	min.	min.	min.
7	3	1	7.5	12.0	15.0	16.0
7	3	2	6.0	7.0	8.0	9.0
7	3	3	3.5	7.0	10.5	11.0
7	3	4	3.3	5.5	9.5	9.75
7	3	5	2.25	4.5	8.0	9.75
7	3	6	2.75	6.0	9.5	11.0

TABLE 10

Composition of mixture			Death rate after various periods			
Quantity of Tobacco	Quantity of Calcium Oxide	Quantity of Water	20 minutes	24 hours	48 hours	72 hours
gm.	gm.	cc.	min.	min.	min.	min.
8	2	1	11.0	12.5	13.1	14.8
8	2	2	9.5	11.5	12.0	13.5
8	2	3	7.0	10.5	11.1	13.3
8	2	4	5.0	9.0	10.55	13.2
8	2	5	6.0	10.75	11.55	13.6
8	2	6	12.0	14.0	14.9	15.6

EXPERIMENT III

A study to determine the efficiency of *Nicotiana rustica* dusts (5.05% Nicotine) when kept in air-tight containers for a period of 25 days, as measured by the death rate of cabbage aphids (*Aphis brassicae* Linnaeus). Temperature 25.5°C.

TABLE 11

Composition of mixture			Death rate after various periods			
Quantity of Tobacco	Quantity of Hydrated Lime	Quantity of Water	20 minutes	24 hours	48 hours	72 hours
gm.	gm.	cc.	min.	min.	min.	min.
5	5	3[1]	3.20	7.9	10.3	11.7
5	5	3[2]	3.15	7.45	9.95	11.3

[1]Water added at time of mixing.

[2]Water added after standing in dry state for 25 days.

EXPERIMENT IV

A study to determine the effect of varying the total quantity of *Nicotiana rustica* dust (4.57% Nicotine), hydrated lime and water as measured by the death rate of cabbage aphids (*Aphis brassicae* Linnaeus). Temperature 25.5°C.

TABLE 12

Composition of mixture			Death rate after various periods			
Quantity of Tobacco	Quantity of Hydrated Lime	Quantity of Water	20 minutes	24 hours	48 hours	72 hours
gm.	gm.	cc.	min.	min.	min.	min.
5	5	3	3.0	8.6	13.4	15.7
4	4	2.4	4.25	11.0	14.6	16.9
3	3	1.8	4.6	11.0	14.9	17.3
2	2	1.2	4.9	11.5	15.3	17.6
1	1	0.6	5.0	12.5	16.2	18.2
0.5	0.5	0.3	6.1	14.0	16.9	19.5

Further experimental work showed that the various mixtures giving the best results under laboratory conditions could be effectively used under field conditions. Satisfactory control of currant worms, apple aphids, blackberry aphids, cabbage aphids, leaf hoppers and many other insects were obtained with a 2% nicotine dust made up of ground tobacco, hydrated lime and water. The water content was held at 23% of the entire mix, and the relative proportions of hydrated lime and tobacco varied at will.

Notwithstanding the fact that these dusts contained large quantities of water it was found that they could easily be applied to bushes and trees by means of the ordinary commercial forms of dusting apparatus.

Discussion of Results

Tables 1, 2, 3, 4, Experiment I, show that water added to various mixtures of tobacco dust and hydrated lime causes the volatilization of nicotine to take place quite readily as measured by the death rate or stupefaction of cabbage aphids. A study of these tables indicate that while the rate of nicotine volatilization is increased by successive additions of water up to a certain point, further applications tend to lower the rate of volatilization. Table 5, Experiment I, shows, however, that a certain water content is necessary for maximum volatilization but increased amounts of water did not materially affect this process.

Tables 6, 7, 8, 9, and 10, Experiment II, show on the whole, that calcium oxide was not as efficient a liberant of nicotine as hydrated lime under the same conditions, although it was quite satisfactory. These tables, further show that while a certain amount of water was necessary for the maximum rate of nicotine volatilization, the further additions of water tended to slow up the rate of this reaction in every case. All mixtures were more efficient when made up, owing to loss of nicotine when allowed to stand for one, two or three day periods.

Table 11, Experiment III, shows that a dust kept for a period of 25 days in a sealed container was practically as efficient an insecticide as a dust freshly prepared.

Table 12, Experiment IV, shows that the method used was trustworthy, that the death rate or stupefaction of insects closely paralleled the amount of nicotine present in the various quantities of dust used.

Summary and Conclusions

This investigation had for its purpose the testing of the rate of volatilization of nicotine from ground *Nicotiana rustica* tobacco in order to ascertain whether this type of tobacco could be used as an insecticidal

dust. This ground tobacco was used alone, with lime compounds, with water, or with mixtures of lime compounds and water. The rate of nicotine evolution was measured by the death rate of cabbage aphids.

As a result of these studies the following conclusions seemed justified.

(1) Ground tobacco, used alone, or with water or lime compounds is not efficient as an insecticide in the control of aphids.

(2) Mixtures of ground tobacco, lime compounds and water gave up their nicotine under laboratory and field conditions, and proved to be highly efficient materials for the control of aphids.

(3) Mixtures of the ground tobacco, lime compounds and water may be kept in air-tight containers for a relatively long period of time with no apparent loss in toxicity.

(4) These experiments warrant that due consideration be given the possibility of cultivating *Nicotiana rustica* for its nicotine content alone and to use it in dust form for insect control.[5]

Bibliography

(1) Haley, D. E., Gardner, F. D. and Whitney, R. T. 1924. Nicotiana Rustica as a Source of Nicotine for Insect Control. Science, Vol. 60, No. 1555, p. 365.

(2) Headlee, T. J. and Rudolfs, W. 1923. Some Principles which Underlie the Making and use of Nicotine Dust. N. J. Agr. Exp. Sta. Bul. 381, p. 5.

(3) MacLeod, G. F. and Harman, S. W. 1923. The Aphisicidal Properties of Tobacco Dust. N. Y. Agr. Exp. Sta. Bul. No. 502, p. 12, 15.

(4) Olson, Otto. 1923. Results of Tobacco Experiments in Pennsylvania, 1912 to 1922. p. 25.

(5) Smith, J. B. 1890. Insecticides and how to Apply Them. N. J. Agr. Exp. Sta. Bul. 75, p. 16.

(6) Smith, R. E. 1921. The Preparation of Nicotine Dust as an Insecticide. Cal. Agr. Exp. Sta. Bul. 336, p. 262.

(7) Stedman, J. M. The wooly-aphids of the apple. Mo. Agr. Exp. Sta. Bul. No. 35, p. 36.

(8) Thatcher, R. W. and Streeter, L. R. 1923. Factors which Affect the Volatility of Nicotine from Insecticidal Dusts. N. Y. Agr. Exp. Sta. Bul. 501. p. 3.

(9) Weed, C. M. 1891. Miscellaneous Experiments in the Control of Insects. Bul. Ohio Agr. Exp. Sta., Vol. 4, No. 2, p. 46.

[5]A paper dealing with the yield and nicotine content of *Nicotiana rustica* as modified by fertilizer treatment is now being prepared for publication.

ATTRACTANT AND POISONED BAIT EXPERIMENTS ON THE PELLUCID GRASSHOPPER

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ABSTRACT

Experiments were conducted with grasshopper baits using various materials as poisons and attractants. No striking differences were observed in the various baits as to attractive qualities or killing power.

Various formulae have been recommended for the preparation of poisoned bait to control grasshoppers. Considerable difference of opinion has also existed as to the most effective agent to use as an attractant. Formulae have differed as regards the character of the poison to be employed.

In order to study the effectiveness of different attractants and poisons, experiments with baits were carried out during the seasons of 1923 and 1924 at Egg Harbor, Wisconsin. The field selected for the work consisted of clover and blue grass heavily infested with *Camnula pellucida* Scudd. Observations were made by two general methods: first, by counting the number of hoppers attracted to certain baits, and second, by attempting to determine the percentage of "kill" by the poisoned-plot method.

For the determination of the relative attractiveness of various baits, pieces of heavy cardboard twelve inches square were numbered and placed about five yards apart in a single row. Ounce portions of the baits to be tested were placed each in a small mass in the center of separate cards. At ten-minute intervals hoppers appearing on the cards or feeding on the bait were counted and the number recorded. At the end of every hour the cards were shifted. The first card was moved to the location of the second; the second was moved to the location of the third. The remainder of the cards were shifted in like manner except the last which was brought back to the original location of the first. Subsequent shifts were made accordingly. At the end of every two hours bait remaining on the cards was removed and fresh bait supplied.

The first test was made on July 26, 1923, to compare the attractiveness of bait with and without poison. Portions of bait composed of bran, 100 pounds, water, 12 gallons, molasses, 2 gallons, and amyl acetate, 3 ounces, were placed on six cards bearing even numbers and similar portions of bait containing the same ingredients in the same proportion but with the addition of four pounds of crude arsenic were placed on

another set of six cards bearing odd numbers. By this arrangement the poisoned bait alternated with the unpoisoned bait. The total number of hoppers attracted during the day to the poisoned bait was 10,464; the total number attracted to the unpoisoned bait was 12,401. Thus there is an indication that the poison had a slightly repellent effect on the hoppers.

Experiments were then run in duplicate, using amyl acetate, apple oil, molasses, salt, and soap, each singly and in various combinations or quantities for comparison as to attractive qualities. A mixture of 100 pounds of bran and 12 gallons of water, was used as a common base in each bait and alone as a check. Cards were shifted and baits were changed as before. The results of the counts are given in the tabulations which follow.

Baits	July 31, 1923	Hoppers
Check		1696
Amyl acetate, 3 oz.		2077
	Molasses, 2 gals.	2389
	Salt, 4 lbs.	1801
Amyl acetate, 3 oz.,	Mollasses, 2 gals.	2434
Amyl acetate, 3 oz.,	Salt 4 lbs.	2378
	Molasses, 2 gals., Salt 4 lbs.	1795
Amyl acetate, 3 oz.,	Molasses, 2 gals., Salt 4 lbs.	1655

Although the greatest number of hoppers appeared at the bait containing amyl acetate and molasses, it seemed little more attractive than some of the others.

Baits	Aug. 2, 1923	Hoppers
Check		2931
Amyl acetate, 3 oz.		3085
Apple oil, 3 oz.		2995
Lemons, 12		3217
Soap, 1 lb.		2775

Although the lemon bait attracted the greatest number of hoppers, there seems to be very little difference in the attractiveness of the baits.

Baits	Aug. 9, 1923	Hoppers
Check		1492
Amyl acetate, 1 oz.		1476
Amyl acetate, 2 oz.		1618
Amyl acetate, 3 oz.		1743
Amyl acetate, 4 oz.		1621
Amyl acetate, 8 oz.		1750
Amyl acetate, 12 oz.		1574
Amyl acetate, 16 oz.		1560

On account of the slight difference in the number of hoppers appearing at the baits, one does not feel justified in designating any particular bait as the most attractive.

Experiments carried out during 1924 were similar to those of 1923. The same field was chosen for the work. At the beginning of the experiments the stages of growth of hoppers were first, second and third instars. Experiments were run in quadruplicate. The attractants used were amyl acetate, molasses, lemons and salt. The results of the counts are given in the tabulations which follow.

Baits	June 25, 1924	Hoppers
Check		208
Amyl acetate, 3 oz		247
Lemons, 12		212

The acetate bait in this series attracted the greatest number of hoppers, whereas in similar tests of the previous year lemon bait was found superior to acetate.

Baits	June 26, 1924	Hoppers
Check		142
Amyl acetate, 3 oz., molasses, 2 gals		164
Lemons 12 molasses, 2 gals		160

The results indicate that these baits are about equally attractive.

Attractant experiments were repeated when the hoppers had reached the adult stage. Baits used were of the same composition as those employed in the nymph experiments. Cards were shifted and baits were changed as usual. Experiments were run in quadruplicate. The results of the counts made are given in the following tabulations,

Baits	Aug. 2, 1924	Hoppers
Check		250
Amyl acetate, 3 oz		269
Lemons, 12		289

In these tests lemon bait was slightly superior to acetate bait in the number of hoppers attracted. It is a matter of conjecture, however, whether a repetition of the work would obtain similar results.

Baits	Aug. 7, 1924	Hoppers
Check		373
Molasses, 2 gals		563
Salt, 4 lbs		466

It appears that molasses bait was somewhat superior to salt bait in these experiments,

Baits	Aug. 9, 1924	Hoppers
Check		273
Amyl acetate, 3 oz.,	molasses 2 gals	386
Lemons, 12	molasses, 2 gals	352

Although the bait containing amyl acetate and molasses attracted the greatest number of hoppers, a repetition of the experiment might show results of a different nature since the difference in the number of hoppers attracted to each bait is slight.

Aug. 4. In order to test the effectiveness of various poisoned baits, plots 15 yards square were staked off in the field and baits of different composition were applied. In general, when testing various quantities and kinds of poison, the bait which had attracted the greatest number of hoppers in the corresponding card test was used. In applying the baits, alternate plots were left untreated. By this procedure each poisoned plot was entirely surrounded by an unpoisoned area. Bait was applied during the hour of 7:30 A. M. to 8:30 A. M. After the hoppers had fed a few hours, 100 were collected in each poisoned plot and placed in separate cages for observation. Hoppers used in check cages were taken in a part of the field some distance away from the poisoned plots. The caged hoppers were kept supplied with food. Examinations were made daily for five days and the dead hoppers in each cage were removed and the number recorded. The results of the plot tests are given in Table 1 which follows. The crosses in the vertical columns indicate the ingredients used in the different baits. The figures at the bottom of

Table 1.—Results of Poisoned Plot Experiments on Adults, August 1923

Bran, 100 lbs	x	x	x	x		x	x	x	x	x	x
Sawdust, 85 lbs					x						
Middlings, 15 lbs					x						
Water, 12 gals	x	x	x	x		x	x	x	x	x	x
Water, 10 gals					x						
Lemons, 12	x	x	x	x	x		x	x	x	x	
Salt, 4 lbs				x	x						
Soap, 1 lb						x					
Amyl acetate, 4 oz											x
Molasses, 2 gals											x
White arsenic, 3 lbs	x										
White arsenic, 4 lbs		x				x					
White arsenic, 5 lbs			x	x	x						
Sodium arsenite, 1 lb							x				
Sodium arsenite, 2 lbs								x			
Sodium arsenite, 3 lbs									x		
Sodium arsenite, 4 lbs										x	
Crude arsenic, 5 lbs											x
Percent of hoppers killed	70	71	69	62	70	70	59	59	48	55	70

each vertical column indicate the percentage of hoppers killed by that particular bait, the death rate in the check having been deducted in each case.

Although the bait containing 4 lbs. of white arsenic gave the greatest percentage of killed hoppers, one does not feel justified in concluding that this would be the most effective bait in all cases, since other baits in this group were almost equally as effective. The mortality in the check was 24 per cent.

Similar experiments were carried out earlier in the season while the hoppers were in the nymph stage. Various unforseen factors interfered with the progress of the work and the data obtained were not of sufficient merit to warrant conclusions.

On July 1, 1924, poisoned baits were applied to plots in the same manner as that previously described. Hoppers were collected from each plot and caged. Observations were made on the effects of the baits. Table 2 gives the results of these experiments.

TABLE 2.—RESULTS OF POISONED-PLOT EXPERIMENTS ON NYMPHS, JULY, 1924

Bran, 100 lbs	x	x		x
Sawdust, 100 lbs			x	
Water, 12 gals	x	x		x
Water, 10 gals			x	
Salt, 4 lbs	x	x		x
Salt, 5 lbs			x	
Molasses, 1 gal			x	
White arsenic, 4 lbs	x			
Sodium arsenite, 1 pint		x		
Sodium arsenite, 1½ pint			x	
Sodium arsenite, 2 pints				x
Percent of hoppers killed	64	71	75	70

No great difference in the effectiveness of the various baits is shown. It appears, however, that sodium arsenite has greater killing power than white arsenic. Mortality in the check was 11 per cent.

TABLE 3.—RESULTS OF POISONED-PLOT EXPERIMENTS ON ADULTS, AUGUST, 1924

Bran, 100 lbs	x	x		x
Sawdust, 100 lbs			x	
Water, 12 gals	x	x		x
Water, 10 gals			x	
Molasses, 1 gal			x	
Molasses, 2 gals	x	x		x
Salt, 5 lbs			x	
White arsenic, 4 lbs	x			
Sodium arsenite, 1 pint		x		
Sodium arsenite, 1½ pints			x	
Sodium arsenite, 2 pints				x
Percent of hoppers killed	49	49	56	59

Aug. 10. Poisoned baits were applied to plots as in the preceding tests. Hoppers were collected and caged as usual and observations made on the rate of mortality. Table 3 gives the results.

Although the bait containing two pints of sodium arsenite gave the highest per cent of kill, its superiority as compared to the other baits is slight. Mortality in the check was 18 per cent.

Throughout the greater part of the experiment, records were kept of temperature, humidity, wind velocity, barometric pressure, and condition of sky as to sunshine or clouds. Hoppers are normally active during bright sunshine whereas there is a marked cessation of activity when the sky is clouded, especially if the cloudiness is accompanied with strong winds. No other striking response to change of weather conditions was observed.

About fifty per cent of the hoppers were found to be infested with the nematode *Mermis nigrescens* Dujardin. This parasite may have been the cause of the high mortality in the poisoned-plot check cages.

Conclusions

Data obtained during the progress of these experiments indicate that it is unnecessary to resort to elaborate incorporation of attractants in a bait in order to add to its efficiency when used against *Camnula pellucida* under Wisconsin conditions. Salt or molasses, or a combination of the two, seems to be quite sufficient.

Crude arsenic, white arsenic, and sodium arsenite are apparently equally effective as killing agents. The convenience in mixing bait with sodium arsenite, however, gives it outstanding preference.

CONTROLLING *PSEUDOCOCCUS COMSTOCKI* KUW. ON CATALPA

By W. S. Hough, *Virginia Experiment Station*

Abstract

Pseudococcus comstocki Kuw., is the principal insect enemy of *Catalpa bungei* in northern Virginia, eastern West Virginia and through the Cumberland Valley to Hagerstown, Maryland. Ovicidal properties of various materials were tested. Investigations covering a two years' period showed that the first two generations were controlled by a dormant treatment of hand cleaning and spraying. The third generation caused most of the injury in August and September and was controlled by mechanical methods only.

In connection with a biological study of *Pseudococcus comstocki* Kuw., on *Catalpa bungei* at Winchester, Virginia a number of experiments on

control was made in 1923 and 1924. All of the important features of the biological investigations have been published.[1] The purpose of this paper is to give some of the more important results on control.

Ovicidal Properties of Insecticides

A series of laboratory tests was made for the purpose of selecting the more efficient ovicides. Overwintering eggs were shaken from the ovisacs collected from catalpas and allowed to fall on panes of glass (8 in. x 10 in.) where they were counted and sprayed with an atomizer on the same day as collected. A black cardboard on which centimeter squares were ruled in white was placed beneath each piece of glass. Every square was numbered so that a separate record of the eggs in each square could be kept. All counts were made under a magnification of twenty times. Hatched eggs were detected by the empty egg shell and removed daily. The results are tabulated in Table 1.

No spray was considered worthy of practical attention unless it killed all of the unprotected eggs, for an insecticide which failed to kill all of the unprotected eggs would not likely be any more efficient under actual conditions where the eggs are always more or less protected by the ovisacs.

Eggs sprayed with lubricating oil, Keresol and Sunoco became translucent and collapsed but did not shrivel. Death resulted probably from penetration of volatile products of the oils. Eggs sprayed with lime sulphur began to show signs of wilting in two or three days. Wrinkles appeared on the chorion. Later the wrinkles became more marked and each egg sank into a shriveled mass apparently from the loss of moisture. The shell of the mealy bug egg is not impervious to the action of lime sulphur at any time of the year. The effect was similar on eggs sprayed February 5, March 27, April 30 (at hatching time of overwintering eggs) and July 6. A majority of the eggs sprayed with precipitated sulphur shriveled in the same manner.

Penetration of Ovicides

The more promising ovicides were sprayed on egg masses as they were collected from catalpas. At the strengths given in Table 1 lime sulphur and the three oils were applied by an atomizer and calcium cyanide dust by a Niagara hand dusting machine. Lime sulphur was effective on exposed eggs only. The three oils killed all of the eggs to a uniform depth of one millimeter and the maximum depth at which any of the eggs were killed was about three millimeters. Calcium cyanide "A"

[1] Va. Agric. Exp. Sta. Tech. Bull. No. 29.

dust penetrated egg masses to a depth varying from nine millimeters to twelve millimeters. Carbolic acid (1–20) killed all of the eggs embedded in wax masses to a depth of six millimeters, but when diluted(1–50) maximum effective penetration did not exceed two millimeters in any instance and usually less. Fish oil soap (1 lb.–3 gal., and 5 lbs.–3 gal.) did not penetrate any better than lime sulphur.

Dormant Treatment

On heavily infested trees masses of eggs frequently reached a depth of 20 mm in crotches and crevices. It was obvious that no ovicide tried could be expected to give a satisfactory kill unless the trees were first cleaned with a wire brush. For this purpose a brush six inches long and half an inch wide was most satisfactory. Careful pruning greatly facilitated cleaning out the center of the head. Following hand cleaning various dormant sprays were applied as shown in Table 2. For this work a hand sprayer was used.

When the maximum number of individuals of the first generation was feeding on the foliage in June, leaf infestation counts were made and the results tabulated in Table 2. Control was not as effective in 1924 because less attention was paid to the thoroughness of hand cleaning prior to spraying. However, in every case the first generation was reduced to harmless proportions.

Summer Treatment

Control of the first generation gave temporary relief both seasons, but when the third generation appeared in late summer it was of sufficient size to cause much foliage injury. In the summer of 1924 the trunks of six trees were banded with 8-inch burlap bands immediately below the first limbs. By actual count the maximum number of adults which passed through the center of the head of any one of the trees to oviposit beneath the band was only 28%. On heavily infested trees a survival of 10% of the females of the second generation was sufficient to start a third generation which could mar the foliage in August and September.

Four trees were sprayed with Keresol (1–40) and a like number with Atlantic red engine oil (1–50) in August 1923. Foliage burning was very severe on all trees and only about 20% of the mealy bugs were killed. Other summer treatments are listed in Table 3. Three trees were used for each treatment given, and a hand sprayer or duster was used at all times except for the water when a Hardy Big Three was used. The percentage of kill was determined by counting all of the dead and

live individuals on one of the trees used in each test. An estimate of the proportion of mealy bugs knocked off by the water was made by counting the mealy bugs found on one tree before and after the application.

Calcium cyanide "A" and "B" dusts gave an excellent kill but foliage injury was so severe that neither could be considered practical at the dosage used. When the "B" dust was diluted with an equal part of lime only slight burning resulted but the percentage of kill was inadequate. The last two treatments listed controlled the third generation and without injuring the appearance of the trees. Hand cleaning consisted of brushing the bark and cleaning out the center of the head of each tree at the time when the maximum number of females of the second generation were ready to oviposit.

TABLE 1.—EFFECT OF INSECTICIDES ON EGGS OF *Pseudococcus comstocki*

	Date 1923	Number of eggs Sprayed	Hatched	Percent hatched
Atlantic red engine oil, 1–50	Feb. 5	3749	0	0
Lime sulphur, 1–7	"	2598	0	0
Lime sulphur, 1–7 and Blackleaf 40, 1–500	"	1764	0	0
Carbolic acid, 1–1000	"	3673	3285	89
Check, 3540 eggs			3179	90
Carbolic acid, 1–100	Mar. 8	1547	1479	96
Blackleaf 40, 1–500	"	1529	1189	78
Keresol, 1–15	"	1618	0	0
Check, 1863 eggs			1722	93
Carbolic acid, 1–50	Apr. 7	964	40	4
Blackleaf 40, 1–500	"	1136	586	52
Check, 1737 eggs			1278	74
Fish oil soap, 1 lb.–3 gal.	Apr. 13	783	36	5
2 lbs.–3 gal.	"	989	27	3
5 lbs.–3 gal.	"	918	84	9
Check, 1002 eggs			846	84
Precipitated sulphur, 1–20	Apr. 19	1734	588	34
1–15	"	979	204	21
1–10	"	1715	252	15
1–5	"	1066	182	17
undiluted	"	698	126	18
Check, 1554 eggs			1281	82
	1924			
Sunoco, 1–20	May 5	872	0	0
Check, 963 eggs			802	83

TABLE 2.—EFFECT OF DORMANT TREATMENT ON THE FIRST GENERATION OF *Pseudococcus comstocki*

	Date treated	No. of trees	No. of mealy bugs per 1000 leaves in June
	1923		
Atlantic red engine oil, 1–50	Mar. 26	2	53
Keresol, 1–15	"	2	98
Lime sulphur, 1–7	Mar. 27	2	27
Check		3	2876
	1924		
Nabob engine oil, 1–50	Apr. 23	4	121
Sunoco, 1–20	"	4	137
Lime sulphur, 1–7	Apr. 1	2	109
Cleaned and pruned, not sprayed	Apr. 9	5	210
Check		2	1895

TABLE 3.—EFFECT OF SUMMER TREATMENTS ON *Pseudococcus comstocki*

	Date	Results
	1923	
Calcium cyanide, "A" dust	Aug. 24	100% kill.
"B" dust	Sept. 15	98% kill.
"B" dust-hydrated lime, equal parts	"	8% kill.
Nicotine dust, D-11	Sept. 3	1% kill.
	1924	
Blackleaf 40, 1–500	Aug. 14	11% kill.
Water—250 lbs. pressure	"	Knocked off about 95% of mealy bugs.
Hand cleaned	Sept. 1	Satisfactory control, 182 young per 1000 leaves late in September.

SULPHUR-IMPREGNATED CLOTHING TO PROTECT AGAINST CHIGGERS

By H. E. EWING, *Bureau of Entomology, United States Department of Agriculture*

ABSTRACT

The successful use of sulphur in impregnating clothing is reported in this paper. The sulphur was used in powdered form in suspension in a strong soap solution. Both inner and outer garments were treated and in each case almost perfect protection was obtained. When sulphur is dusted on the skin or sifted inside of loose garments, according to the usual custom in this country, it may collect along seams or in folds of the garments where it causes burning. Effective protection is more easily obtained by impregnating a part of the clothing.

The value of impregnating clothing with insecticides in order to protect man from the attacks of body lice was first demonstrated during

the World War. It was while working on "cootie clothing" to help supply one of the units of the American army being trained at Camp Dodge, Iowa, that the idea occurred to the writer of making use of this general principle of impregnating clothing to protect man against "peace time" enemies. At first it appeared that repellents against mosquitoes could possibly be applied in an impregnated form either to the underwear or to the shirt of the wearer. Of other insect enemies that might thus be repelled attention was centered on "seed" ticks and chiggers.

It was against the last named that the idea was first worked out during the summer of 1923. So successful were these first attempts that in the following summer of 1924 further experiments were tried and with most gratifying results.

Although the use of sulphur in protecting against chigger attacks had been known for many years, the old method of sprinkling the powder inside the breeches or stockings had resulted in some instances in severe burning of the skin or in the accumulation of the fine-grained sulphur on the plantar surface of the foot where it caused discomfort while walking. The writer believed that if the sulphur was impregnated in the stockings or underwear the effects of burning and the accumulation of an excess of the free powder on the skin could be avoided.

Accordingly, one-fourth of a pound of naphtha soap was dissolved in a gallon of hot water and one-half of a pound of finely powdered sulphur added and mixed thoroughly. In this mixture socks and underwear were dipped, wrung out and dried on the line over night. Only the tops of the socks were immersed. This was to avoid having the gritty feeling of powdered sulphur on the bottom of the feet. After the dipped clothing was dry, most of the free sulphur was shaken out and the clothing placed in a box for future use.

Clothing thus treated gave almost complete protection against chig-

EXPLANATION OF PLATE 7

(Photographs by the writer)

A. Wrap puttees impregnated with sulphur-soap suspension. To be worn in the usual manner for protection against chiggers.

B. "Sleeves," made by cutting toe ends off of large size socks,—impregnated with sulphur-soap. To be worn over shoe tops and stockings but under trouser legs to protect against chiggers.

C. Child's "cover-alls" with the lower part impregnated with sulphur-soap.

D. Sulphur-soap impregnated "cover-alls" with bottoms of legs tied so as to give further protection against chiggers. Where low shoes are worn as in this picture the excess sulphur on the legs of the "cover-alls" should not be shaken off as it is needed to dust the stocking while being worn. In this instance the protection was complete.

Sulphur-impregnated clothing for protection against chiggers.

gers. However, too much free sulphur had been left in so that it gave a slight amount of burning when it collected on the skin. Also the wearing of sulphur-impregnated underwear gave a rather strong odor to the body, but in general the experiment was very successful.

In order to obviate these difficulties in 1924 it was decided to use more soap (for binding the sulphur) and less sulphur; also in addition to impregnating the clothing worn next to the skin, to impregnate certain outer garments and also to impregnate a "sleeve" (Pl. 7, B) to be worn over the shoe tops and stockings of the leg but under the trouser leg.

Of the outer garments wrap puttees (Pl. 7, A) and "cover-alls" (Pl. 7, C) were impregnated, only the legs of the latter being doused. Sleeves were made by cutting off the toes of heavy socks or stockings. These were purchased of a low grade and one or two numbers too large. When chigger protection was desired the "sleeves" were taken out of the pocket and pulled on over the shoes into the desired position. The legs of the "cover-alls" were tied at the bottom before entering the chigger infested area as shown in Plate 7, figure D.

During the summer several individuals wore these various impregnated garments, and in every instance with almost perfect protection and also with practically no ill effects from burning, etc.

At one time during the summer the writer took his family of three, after each was protected with impregnated clothing, into a chigger-infested swamp to see an eagle's nest. Although all of us were exposed for over an hour to gross infestation from chiggers not a single one attached to any of us.

The formula used in 1924 for dipping is as follows:

Naphtha soap	¼ lb.
Water	1 gal.
Flowers of sulphur	¼ lb.

As in the previous summer the excess of sulphur was shaken from the clothing before the latter was put on.

THE PINE NEEDLE MITE, A NEW ENEMY OF THE PINES, ERIOPHYES PINI NALEPA[1] FAMILY *ERIOPHYIDAE*

By ERIC WALTHER[2]

ABSTRACT

The above mite, found in the United States as far as known only at San Francisco and at San Diego, feeds within the basal sheath of the needle-cluster, *Pinus radiata* Don and *P. torreyana* Carr. being the recorded hosts. As a result of its work the affected needles are shed prematurely, and the annual repetition of this leafcast can not fail but weaken the trees, to the extent of shortening their life appreciably, besides apparently predisposing them to attacks by bark-beetles. Fortunately the pest seems to be able to spread but slowly, with consequent hope of its ultimate control. Spraying experiments have given some promise,—a 10 per cent miscible-oil-spray being indicated as most productive of results. Further work is needed to determine the best season of treatment and the number of applications necessary. Where possible, the removal of infested pines furnishes a prompt and effective remedy not to be approached by spraying.

INTRODUCTION

For some years now the condition of many of the pines in Golden Gate Park had been a cause of concern. During the winter they would shed most of their needles, apparently recover in spring, only to repeat the performance next season. At the instance of Mr. John McLaren, Park Superintendent, the writer began an investigation, rather superficial at first, and soon found that none of the various insects and fungi affecting the pines could account for all the features of the trouble, especially the erratic distribution of affected trees. In the summer of 1924 the presence of the pine-needle-mite was discovered, almost simultaneously with, but independently of its discovery near San Diego.

HOSTS

As far as known, *Pinus radiata* Don and *P. torreyana* Carr., are the only hosts of this mite in this country. In Europe it is reported from *P. laricio* Poir., *P. sylvestris* L. and *P. cembra* L., the last being a white pine.

DESCRIPTION

The adult mite is less than 1/100 inch long and appears under the hand lens merely as a fine yellowish line, the eggs and young being white. Finer details are hard to observe even under the microscope, and for a

[1]Identification by Dr. H. E. Ewing, U. S. National Museum, who wishes it to be considered for the present as strictly provisional.

[2]Investigations and control-experiments conducted at the instance of John McLaren, Superintendent, Golden Gate Park, San Francisco, by whose consent this is published.

more complete description Dr. Nalepa's *Eriophyidae* in *Das Tierreich* should be consulted.

Habits

If the sheath surrounding the base of the needles be stripped off carefully, there will be found, during most of the year, on all pines affected by this type of leaf-cast, large numbers of the mite. Towards the end of winter, though, they seem to disappear from their usual hiding-place, and probably will yet be found to hibernate under the budscales, as does *E. pyri* Pagenst. When the trees begin to grow in spring, as soon as the young needles protrude from the sheath, adult mites, and probably females, appear there. Soon after the few and relatively large eggs are laid, to hatch in a few days. The young mites usually feed at first all in the same spot, forming a small colony. How many generations there are each season is still uncertain, but the first one in spring seems to last about 2 months. Observations on this point are difficult because of overlapping, but in any case mites are sufficiently numerous to thoroughly reinfest the trees from the few often surviving the winter.

Nature of Work

In Europe *E. pini* Nal. is said to cause knot-like galls on the branches, and the failure of the mite present here to produce these is one reason for thinking it to be a distinct variety, if not species. So far we have found the mites only within the needle-sheath. While a single mite is too small to do much damage, the large numbers developing slightly roughen and discolor the base of the needles, and the injury appears sufficient to account for the premature fall of the needles at the end of their first year. A majority of the fallen needles show signs of fungous injury, caused by a species of *Pestalozzia*[3] but it would hardly be safe to attribute the leaf-cast to the fungus alone, which is much more likely only secondary. The leaf-cast is quite striking, especially during spring, but affected pines can always be spotted by their thinner crown of paler foliage, as well as the distinct orange-brown color of the fallen needles. In dry seasons the injury is much more apparent, and the reverse also holds good, as where a tree seems to recover following the application of fertilizer or the beginning of regular irrigation. A simultaneous attack of the pines by some of the many other pests listed below[4] will also in-

[3]According to Dr. Meinecke of the U. S. Bureau of Plant Industry.

[4]Some other local enemies of the Monterey Pine are: *Aphrophora permutata* Uhl., *Argyresthia pilatella* Braun, *Dendroctonus valens* Lec., *Ips radiatæ* Hopk., *Lachnus pini-radiatæ* Davids., *Physokermes insignicola* (Craw.), *Pineus pinicorticis* Fitch, *Rhyacionia pasadenana* Kearf., *Thecodiplosis pini-radiatæ* (Snow and Mills.)

crease the severity of the leaf-cast, and it is therefore not surprising that several of these should at various times have been held responsible for the injury, really due to the mite, whose small size and retiring habits also served to delay its discovery. The ability of an infested pine to renew its foliage-crown year after year seems to indicate a rather fine balance between its vitality and the mites opportunities for increase and survival. Lack of safe hibernating-places on defoliated trees may well be the limiting factor, since the mortality of the mite, through enemies, winters rigors, etc., is quite heavy. Nevertheless the repeated loss of foliage is bound to weaken the trees, and most pines infested for any length of time are noticeably stunted. Actual measurements show that the average number of annual rings in the last outer inch of sapwood of infested pines is 11.15, as against an average of 8.62 for healthy trees. This decrease in annual increment of over 20 per cent may well indicate a like reduction of ultimate age. Absence of proper records makes it uncertain just to what extent the mite-injury predisposes the pines to attack by bark-beetles, but practically all pines killed in the park during the last few years by *Ips radiatæ* Hopk. were mite-infested.

Distribution

Typical *Eriophyes pini* Nal. is found in Central Europe, in Upper Italy and Southern Tyrol. Our mite is reported in California from San Francisco, in Golden Gate Park and at the Presidio; and from San Diego, in Balboa Park and at Del Mar on the Torrey Pines. Whether this species is identical with the European one is still uncertain, but it might very well have been imported on living pines. While the presence of the mite has been established only recently, it seems to have been at work for quite a while, as is shown by the evidence of a rough survey. This consisted of the taking of cores, with an increment-borer, of about 250 trees. All infested pines showed a sudden decrease in width of the annual rings, presumably due to the mite-injury, and in some cases this seems to date back over 20 years, which is borne out by the appearance of the trees as well as by local tradition. Infested pines are distributed quite erratically, and are equally numerous to the windward as in more sheltered places. This seems to dispose effectively of the theory that the injury is due to the above-mentioned fungus, since that is spread by windborne spores. The fungus-theory also fails to account for the remarkable fact that a quite healthy Monterey Pine may be found growing quite close to a badly infested one, even to leewards of it, without necessarily becoming infested for a long time. Density of stand seems to have little influence on the degree of infestation, but this last certainly

increases with the age of the trees. While there are some pines less than 10 years of age infested, the younger stands are on the whole fairly clean. This increase of infestation with age would be even more pronounced but for our long-continued practice of thinning, which no doubt served to remove many mite-infested pines. That this is an important means of control is shown by the condition of the trees near Fort Winfield Scott on the Presidio Reservation, where no thinning seems to have ever been done, and consequently over half of the pines are now infested.

Just how the mite spreads is as yet only conjectural, but it could hardly do so by its own powers of locomotion, and much more likely is carried by birds, squirrels or insects. As to the last possibility, we call attention to the well known habit of various *gamasoid* mites of attaching themselves to insects, as bark-beetles, for transportation. The writer has seen some of these mites attached to even quite minute hymenopterous parasites, barely able to stagger under the load. Even if no actual observations prove this to be the case on the part of the *Eriophyidae*, something like it evidently takes place. Certainly dispersal can only be due to occasional accident, or all pines would have been long since overrun.

Natural Enemies

Due to its small size the pine-needle-mite appears to be free from internal parasites, and its inaccessible hiding-place protects it from most predators. When the sheltering sheath becomes loosened with age, or when the mites are migrating, they are more apt to become the prey of their enemies. Of these the most important seems to be larger mite of the genus *Seius*.[5]

While this is present on all pines, it is certainly much more abundant on mite-infested trees.

Control

Control-measures would seem to resolve themselves under three heads, to wit: Spraying, modifications of forestry-practice and possibly the biological method. The relatively slight economic importance of the Monterey-Pine makes it unlikely that local interests would undertake the expense of introducing predators and parasites. Work of that nature will have to be left to the State and Federal authorities, who would well be justified in undertaking it in view of the extensive forest-reserves in California, possibly endangered by the mite.

Spraying might seem rather hopeless at first because of the inaccessibility of the mite, but in the course of some experiments it was

[5]Identified by Dr. H. E. Ewing of the U. S. National Museum.

found that a fairly strong oil-spray would soak right through the leaf-sheath, killing most of the mites without producing any marked injury to the pines. Owing to lack of space we can give here only a summary of the more successful experiments:

A. No. 12. Miscible-oil (CALOX), 20 per cent., 2 applications in April. Kill: 95 per cent. Injury none.

B. No. 32. Lubricating-oil emulsion, home-made,[6] 10 per cent., one application in June. Kill: 90 per cent. Injury slight.

C. No. 29. Lubricating-oil emulsion, (ROGERS SPECIAL) 7½ per cent., in June, one application. Kill: 90 per cent. Injury marked.

D. No. 38. Miscible-oil, (CALOX) 7½ per cent., in June, one application, Kill: 80 per cent. Injury none.

E. No. 22. VOLCK CONCENTRATE, 7½ per cent., one application in June, Kill: 70 per cent. Injury slight.

Experiment A., would seem to have been the most successful, owing perhaps rather to its early application than to the strength used. B. was only slightly less effective, the observed difference being well within the limits of error in estimating the kill, and perhaps due to the larger number of mites present at that date. The much lower cost of the latter material would cause us to provisionally recommend the use of 10 per cent Oil-spray, emulsified with Calcium-Caseinate,[6] and using a rather heavy oil, as the so called Red Engine-oil or a Flushing-oil, Kerosene Emulsion having given no results whatever.

No data are available as yet on the effectiveness of this spray when used earlier, *i. e.*, when the buds are opening in spring. Further experiments are needed to show whether a weaker spray might not then be sufficient, as well as to determine the most opportune time of application. Spraying later than June reduced the numbers of mites only temporarily. Difficulty was experienced in covering the taller trees thoroughly with the Orchard-sprayer available, and the use of a high-pressure, large-

[6]The complete formula reads: Dissolve 2½ lbs. of Calcium Caseinate in a little water, add to tank holding about 15 gallons of water, with the agitator running, when well mixed add 20 gallons of heavy oil, emulsify well by playing the nozzle on the top of the water, then add enough water to make 200 gallons of spray, agitating all the while.

The cost of spraying an average sized pine once with this material works out at about $0.75, based on the following assumptions: Cost of oil, per gallon, $0.15; Calcium Caseinate, per lb. $0.20; Gallons of spray needed per tree, about 20; Number of trees sprayed per day, about 50; Labor-cost, etc. per day, about $20.00.

Operating on a large scale, using a machine of large capacity, this cost could be reduced materially.

capacity sprayer capable of supplying a Worthley-nozzle is imperative if lasting effects are to be achieved. As it seems unlikely that a 100 per cent kill will ever be attained by any spraying, the benefit derived from that will at best be only temporary. If we add to this consideration the rather high cost of spraying this would seem to be justified only in the case of individually valuable trees, or in smaller parks and gardens.

Where large forest-areas are affected, remedial-measures would have to consist of the removal of infested trees. If this was done before many trees become affected, it might result in a permanent cure, but that may become impossible if delayed until most of the trees are infested. Then, because of the fortunately slow spread of the pine-needle-mite, it should be possible to clean the forest gradually through the annual clear-cutting of part of its area, followed, if necessary, by replanting. Whether the injury caused by the mite is serious enough to warrant such drastic measures may be considered doubtful; and would have to be determined in each individual case. Since the Monterey-pine is a rather short-lived tree anyhow, the possible reduction of its maximum-age by 20 per cent would merely result in a like decrease in the rotation, implying a corresponding increase in the area cut, and planted, annually. Once the presence of the mite is known, it should be easy to keep the young stands clean by the prompt removal of such of the young pines as may become infested, as even they develop the characteristic leaf-cast very markedly. Continued watchfulness is needed, though, as a pine growing under favorable conditions may show little evidence of injury during most of the year.

Summary

The real danger of the Pine-needle-mite would seem to be the relative obscurity not only of itself, but also of the resulting injury, causing it to be overlooked or to be considered unimportant. Nevertheless the damage is quite real, as may be seen from the measurements quoted above. While there is still much to be learned about the habits of the mite, its slow spread seems to be an established fact, this giving hope for its ultimate control, if not eradication. Spraying with a 10 per cent strength of Miscible-oil has given some promising results, but further experiments are yet needed to show not only the best time of application, but also whether the benefits derived will be lasting. On a large scale gradual or immediate removal of infested trees may prove to be the real cure, if thoroughly done and followed by careful observations of the remaining trees.

In conclusion we wish to thank our many friends, whose help made the work possible, and we hope that these lines will prove of interest and possibly also of use to them and others. We invite any criticism and would be thankful for any observations on the habits and distribution of the mite, as well as for information of control-experiments.

Read and approved for publication by

JOHN MCLAREN
Superintendent.

Scientific Notes

Trigona laeviceps as a Pest. Dr. H. M. Smith writes from Bangkok, Siam, sending specimens of the small bee, *Trigona laeviceps* F. Smith, which he says is the greatest insect pest in Bangkok, next to mosquitoes. "It is abroad during daylight, is extremely active and hard to get, has the habit of getting in one's ears, eyes and nose, especially when one has both hands busy, is found to produce a high-pitched buzz when within an inch or two of one's ear, and when driven off comes right back. Up to half a dozen may be about one's head at one time, and as I write you I am constantly driving them away with a towel" (letter of May 13, 1925).

T. D. A. COCKERELL, *University of Colorado*

The Cicada Killer (*Sphecius speciosus* Dru.) in a Peculiar Location and its Elimination with Calcium Cyanide. During July of the past summer the ground superintendent of a large Philadelphia estate requested methods for control of a "large hornet" which was tunneling the beds in a formal garden. Upon visiting the place approximately fifty burrows about one inch in diameter were found in the beds of a formal planting which were bordered with gravel walks. The small boxwood bushes forming the edging and the herbaceous plants within the beds had died out in many places above these tunnels and the effect of the planting was being destroyed. A large number of cicada killers, *Sphecius speciosus* Dru., were flying about and alighting on the walks. When a burrow was approached one or more of the insects would fly about in such a threatening manner as to make one hesitate about venturing too close. Forty or more of the insects were collected with a net but the number still at large was apparently not decreased. Following a suggestion, the superintendent placed a teaspoonful of calcium cyanide in the opening of each burrow, and upon revisiting the place two days later not a single live killer could be found. In the opening of many burrows were found one or more dead individuals each and many more were seen lying about in the beds and walks. No more trouble has been incurred in this location but it will be interesting to note the presence of any next year which may develop from the immature individuals in the burrows. The presence of so large a number of individuals and their occurrence in such a location, I believe, is rather out of the ordinary for this species. The eradication of this insect by means of calcium cyanide compares with the control of *Vespula carolina* Linn. as reported by W. W. Yothers in JOUR. EC. ENT. Vol. 18, No. 2, pp. 368. April 1925.

FLOYD F. SMITH, *Pennsylvania Bureau of Plant Industry*

Hemlocks Attacked by a Little-known Geometrid. An insect outbreak which has attracted an unusual amount of public attention this season in Wisconsin is that of *Ellopia fiscellaria* Gn. on the hemlocks. The reason for the popular discussions of this span worm is the amount of damage which it is doing in Peninsula State Park in Door county, north of Sturgeon Bay.

At this location the hemlocks have been extensively defoliated and many of them are dying as a result of the feeding of the worms. In addition to hemlocks, pine, choke cherry and balsam are acting as hosts but the injury to them is much less severe. The superintendent of the park first reported the damage in July and the work of the larvae, which were present in tremendous numbers, continued throughout the month.

Pupation was apparently completed about September 5 and on September 19 and 20 the moths were very abundant. While not noticeably attracted to lights, they are large and white and therefore show up conspicuously in the vicinity of artificial lights at night.

The empty pupal skins found by Mr. Granovsky, of the Wisconsin Experiment Station, on September 20 were in crevices of bark, while those found by the writer were attached to leaves on the ground. The moths have been found abundant in hemlock in sections of the park where defoliation was not noticed this year and also in other parts of the peninsula. A closely related insect, *Ellopia somniaria*, is said to have caused serious injury to the hemlocks of Stanley Park, Vancouver Island, B. C., from 1911 to 1913. There, parasites wiped out the infestation in 1914 and there seems to be no more recent record. Thus far the parasites in the Wisconsin infestation have shown no indications of getting a start.

Although this seems to be the first case on record of serious damage by this species, it is probable that the area over which the hemlocks are attacked this season is fairly extensive. Professor Pettit reported to the insect pest survey on August 28 that damage was being done by the same species to hemlock and balsam at Leland, Michigan. There is an unconfirmed rumor of similar injury extending down into Ohio.

As a control measure in the Wisconsin infestation, should the outbreak continue into 1926, airplane dusting is planned and preliminary arrangements for the planes and the dusting material have already been made.

It may also be of interest to note that in the October 1925 JOURNAL, Dr. Felt publishes a report of an infestation of hemlocks at Rhinebeck, N. Y., by a spanworm of which the larvae were identified by Dr. Dyar as a different species from the one in Wisconsin, but the adults of which were not secured.

S. B. FRACKER, *Madison, Wisconsin*

Codling Moth Eggs Hatching Under Water. In some recent studies it was found desirable to have eggs of the codling moth deposited on a glass surface. This was accomplished merely by confining a few dozen moths in a battery jar. One afternoon the eggs continued hatching when there was no further use for the larvae in the experimental tests until the following day. For the purpose of possibly retarding development in the eggs and preventing any more larvae from hatching, the jar was filled with tap water about 5 P. M. The temperature of the water was about 62°F. There were approximately three hundred unhatched eggs on the sides and bottom of the jar. Upon examination of the jar at nine o'clock the following morning, the writer was much surprised to find that thirty-six larvae had hatched and were alive, clinging to the surface of the jar and completely submerged in water. They exhibited

slight movements. Some had crawled a centimeter or more from the eggs where they had hatched. The jar was kept under observation until 11:30 A. M. at which time a total of fifty-two larvae were counted. The water was siphoned from the jar and the larvae transferred to the laboratory table. All were alive. About twenty were placed on an apple suspended by a piece of thread. Their movements at first were quite sluggish compared with larvae hatching under normal conditions, but they did not seem to be materially affected as regards their ability to burrow into the apple. The remainder of the eggs hatched normally.

No attempt was made to determine why the larvae were able to remain alive under water for so long a time. Possibly a small quantity of air within the egg shell formed a film over the larva, which served to keep it alive. Larvae which were observed to fall onto the surface of water usually drowned within a few hours. The observation was of some practical interest because we have suspected that in sections of the country where heavy dew forms on apple trees, developing larvae might be suffocated or harmed to an extent by the eggs being covered with drops of dew. The casual experiment just mentioned would seem to indicate, however, that dew would not materially interfere with the hatching of codling moth larvae.

RALPH H. SMITH, *Stanford University*

A New Departure in Codling Moth Control. Within the last ten years the codling moth, *Carpocapsa pomonella* has become the most serious insect pest of the English walnut in Southern California. In Santa Barbara County, and in Orange County the losses are very severe. Lying between these centers of infestation is the highly productive walnut growing district of Saticoy, Ventura County, which is comparatively free. In this district the menace of the codling moth was first generally recognized in the fall of 1922 when an examination of nuts delivered to the packing house of the Saticoy Walnut Growers Association showed that in a few lots as many as three per cent of the nuts were worm-damaged.

The directors of the Saticoy Association decided to make every effort to prevent an increase of the moth in the three thousand acres comprising their Association. Accordingly, twenty thousand dollars was placed at the disposal of an entomologist engaged to take charge of the work. The permanent nature of this work is expressed in a substantial laboratory building which, in 1923, was constructed and equipped with the necessary apparatus for research at a cost of $2,570.00.

Life-history observations are carried on in the laboratory and in the field. For the past two seasons University of California students of the Department of Entomology have been employed in field inspection work.

Between July 15 and August 15 every orchard is inspected in order to determine the infestation per tree. Those orchards having an infestation of over five wormy nuts per tree are dusted with arsenate of lead the following year. Each year one application of dust is made within ten days after the peak of egg deposition. As a supplementary measure, thirty days after the peak of egg deposition the wormy nuts are picked in those orchards having an infestation of over fifteen per tree. In 1925 a fifteen acre orchard had an infestation of 31.84 on July 27th. By hand-picking the most heavily infested trees a crew of four boys in four days reduced it to 6.25 per tree.

The yearly cost of this work is between ten and fifteen thousand dollars. Since Saticoy growers will receive about one and a half million dollars for this year's crop it is well worth their while to protect it in the years that follow.

That there has been no increase in the percentage of worm-damaged walnuts at the packing house is sufficient evidence to the grower that the effort has been worth all it cost. The directors of the Saticoy Association appreciate the fact that the greatest economy is realized through a "prevention" control program rather a "reduction" control.

It is this advanced "be prepared" attitude of an association of growers toward their pest problems that is unique in the annals of organized warfare against Insects.

STANLEY E. FLANDERS

On the Methods of Destruction of Mosquitoes. In Russia, measures are taken both against the larvae and the adult stage of the mosquito. The destruction of the winged mosquito is usual in winter, and consists in the destroying of mosquitoes hibernating in unheated buildings,—stores, barns, and granaries.

A series of successful experiments on the use of tobacco-smoke for destroying hibernating mosquitoes has been recently executed by the Scientific-Research Laboratory of the Plant-Protection Department. The smoke was obtained by burning tobacco-powder[1] in the proportion of 30–40 gr. to one cubic meter. The

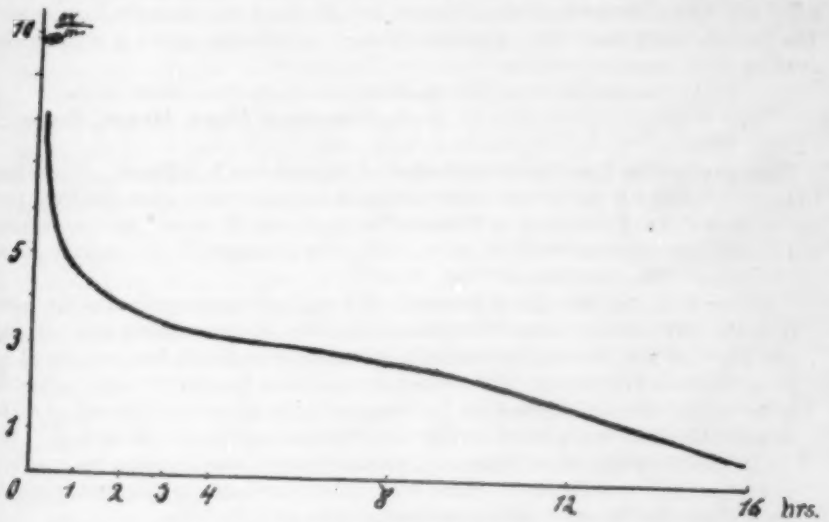

FIG. 24.—Chart showing dose and time factors relations, the curve indicating lethal conditions.

tobacco-powder was mixed with some chopped straw or hay, and left to smoulder in the room on iron sheets. This disinfection lasted 16 hours, after which the percentage of dead mosquitoes amounts usually to 100%.

The influence of nicotine on mosquitoes was also investigated under laboratory conditions. These experiments were carried out in bell-glasses of 11 liters of capacity. A water-solution of nicotine was used as the initial product. Glass tubes containing

[1]The powder was a remnant from tobacco-factories.

the mosquitoes, and covered on both ends with muslin, were placed under the bell glasses. Porcelain saucers containing about 15 grms. of unslacked lime were also put under the bellglasses. The nicotine solution diluted with water to the total quantity of 3 cub. cm. of liquid, was poured out upon the lime; the heat produced by the slackening of the calx is accompanied by the formation of steam, which bears the nicotine away with it. The temperature and pressure under the bellglasses were controlled throughout the experiments. The results are given in table, from which it may be seen, that by lengthening the duration of exposure to nicotine of mosquitoes (*Culex pipiens* L. and *Anopheles maculipennis* Mg.) from 5 min. to 15 hours, a diminution of the lethal dose of nicotine from 8 to 0.5 gr. to the cubic meter of room is permissible.

It was remarked, that smaller doses or shorter exposures produce only a temporary stunning effect on the mosquitoes, which recover in the fresh air after the end of the experiment.

As to the symptoms of nicotine-poisoning, it must be noted, that the abdomen of some of the mosquitoes was abnormally extended. The same phenomenon was constantly present in the nicotinised cockroach (*Stylopyga orientalis* Lin.) The rings and half rings were disunited and a thin cuticle was to be seen between them; the latter was blown on the neck like a blister, and the head was therefore bent down. The genitals stuck out. The dissection of such cockroaches shows a remarkable swelling of the anterior intestine.

T. A. PARFENTJEV, *Scientific Research Laboratory, Department for the Protection of Plants, Moscow, Russia.*

Cyanogas Calcium Cyanide for the Control of *Atta sexedens* L. in Brazil. Cyanogas Calcium Cyanide has for its base the chemical element nitrogen, extracted from the air by electric power generated at Niagara Falls in North America. Just two essential points need emphasis with regard to the use of Cyanogas in the extermination of the sauva. These are that:

(1) For more than 30 years hydrocyanic acid gas has been recognized as the most powerful and therefore the most efficient insecticide. During all this time nothing else has been able to compete with it, and it has consequently been employed in all cases where practicable. But it was not practicable to apply it to formigueiros with the pot method of generation by means of sulphuric acid, water and cyanide of soda, which for many years was the only method used in its production.

(2) Two years ago, when Cyanogas Calcium Cyanide was placed on the market, it first became practicable to apply hydrocyanic acid gas to the formigueiros, since Cyanogas generates this gas on being blown into the holes.

Some 25 years ago, when the use of hydrocyanic acid gas as an insecticide was comparatively new, Dr. Dafert, then director of the Instituto Agronomico of the State of Sao Paulo at Campinas, experimented with it against the sauva. In his report on experiments with all formicides known at the time, he stated that hydrocyanic acid gas is 100% efficient and no other formicide can compete with it, but he explicitly states also that he can not recommend its use on account of the danger attendant upon applying it. About 5 years ago, in a bulletin on sauva and the best known formicides, the writer, then with the Director of Agriculture of the State of

Note: Sauva— Leaf-cutting ant, *Atta sexdens* L. Formigueiros— Underground galleries or nest of *Atta sexdens* L.

Sao Paulo, stated that without doubt hydrocyanic acid gas would supersede all other formicides once a practical method was devised of applying it to the formigueiros. Cyanogas Calcium Cyanide was still unknown, but its appearance two years ago solved the problem of the practical and simple application of hydrocyanic acid gas to the nests.

With only ordinary precautions, there is absolutely no danger in the application of Cyanogas. The dust and the vapors given off by it should not be inhaled, the dust should not get into the mouth nor should it come in contact with skin abrasions. In the open air there is no danger of inhalation, in a closed space of humid air the handling of open tins of Cyanogas would be dangerous. In case of any effects arising from inhalation, the antidote is fumes of ammonia inhaled and artificial respiration if necessary. The writer has used Cyanogas Calcium Cyanide for two years without the slightest ill effect. Moreover, the Brazilians have long been familiar with this poison, for hydrocyanic acid gas is the active principle in the poisonous juice of bitter mandioca.

Full strength Cyanogas Calcium Cyanide is about 48 to 50% cyanide of calcium. It must be used in finely powdered or dust form for application to formigueiros, and the full strength or Grade "A" Dust should be employed for this purpose. Cyanide of calcium dissociates rapidly in the presence of moisture, whereas other cyanides do so only slowly. Cyanogas takes up the water from the humid air of the tunnels and panellas, while the cyanide content combines with this water to form HCN or hydrocyanic acid gas. The chemical reaction is as follows:

$$Ca(CN)_2+2H_2O=2HCN+Ca(OH)_2$$

Which is to say that 1 molecule of calcium cyanide combines with 2 molecules of water to form 2 molecules of hydrocyanic acid gas and 1 molecule of slaked lime.

For many decades numerous patented formicides have been placed on the Brazilian market, each manufacturer claiming not only superiority but infallibility for his product. Each one of these has been tried in turn by the fazendeiros without securing decisive results. In every case it has been found necessary to continue applications year after year, practically never securing extinction of the formigueiros. Therefore the Brazilian fazendeiro has become skeptical with regard to new formicides and is indifferent to the claims made with regard to them, naturally believing all to be more or less alike and none to be capable of exterminating the sauva. For this reason it has been necessary to give demonstrations with Cyanogas Calcium Cyanide free of charge on the largest and most important properties in order to prove the exterminating efficiency of the product and its immense superiority over all other formicides. Once this superiority becomes generally known, there is no doubt of Cyanogas superseding all other preparations as a formicide.

Hydrocyanic acid gas is nearly the same weight as the warm humid air in the nests of the sauva. Furthermore, due to its high molecular activity, it readily permeates and mixes with the air in all directions, up, down, or laterally, throughout all communicating spaces. That it is not heavier than air is an advantage in its use, since a heavy gas would settle to the bottom of the nests and dissipate rapidly through the soil.

The greater part of the hydrocyanic acid gas is formed immediately the Cyanogas Calcium Cyanide dust is blown into the nests, but the reaction continues for some 24 to 48 hours until the process is complete. The nest is thus continuously filled with the gas for sufficient time to kill out any ants that may happen to be outside the nest at time of treatment, for, on returning and attempting to dig in, these ants will

breathe the gas and die. Hydrocyanic acid gas kills the larvae of the ants as well as the adults. It also kills the fungus on which the ants feed, either directly or by removing the ants whose duty it is to care for it. The larvae resulting from any eggs that may hatch after the treatment of a nest die for lack of food and ants to care for them. The extermination of the formigueiro is thus complete. All that is necessary is that the gas reach every part of the formigueiro so that all the ants get one full breath of it.

The amount of Cyanogas Calcium Cyanide required to fill a given formigueiro with hydrocyanic acid gas varies according to the cubic capacity of the tunnels and panellas. It may be stated that, on the average, ten minutes work with the small Feeny duster will use ¼ kilo of Cyanogas. Large old nests of 100 or more openings may require 40 minutes and use 1 kilo of Cyanogas. The largest nests with very extensive communications will require still more. New nests of small extent will require only ⅛ to ¼ of a kilo. Neither water nor fire are to be used in the application of Cyanogas Calcium Cyanide yet the dust issues from communicating holes like a black smoke just as if fire were being used. This property is an absolute necessity in the application of any gas to sauva nests, in order that communicating holes may be located, recognized and closed.

No cleaning of formigueiros preparatory to treatment is necessary other than to cut away matto sufficiently to introduce the tube of the blower into the holes. The less a nest is disturbed before treating, the better will be the results of the treatment. It is important to overlook no holes at the first treatment, in order to secure speedy extinction of the nest. The largest holes should be selected first for treatment, meantime closing all holes from which the smokelike dust issues. The blower should be worked in each hole, from which no smoke has issued, until a pronounced air-compression is felt. Some holes in very large nests may be treated as long as 20 minutes before getting this air-compression, while only a few seconds of treatment will show it in others. Compression indicates that all communicating passages and panellas are well filled with the gas, and the treatment should be then transferred to other holes. But the caution must here be given not to plug either the holes or the tube of the blower with earth while introducing the tube into the holes. Treated nests should be observed daily and all holes found open must be promptly treated and closed. Such application of Cyanogas, carefully carried out, will completely exterminate the nest, and the length of time required for extermination will depend on the experience and technique of the operator and the thoroughness of application without missing any holes.

The best time of year to secure speedy extermination of formigueiros is just before the swarming time, which period varies from September to December according to localities and conditions. At this time excavations are not in progress and the ants are all assembled in the upper parts of the nest attending the broods of queens and drones that are being developed preparatory to swarming.

CHARLES H. T. TOWNSEND

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

DECEMBER, 1925

The editors will thankfully receive news matter and other items likely to be of interest to our readers. Papers will be published as far as possible in the order of reception, except that papers of reasonable length may be accepted in the discretion of the editor for early publication, at $2.50 per page for all matter in excess of six printed pages; in the case of other matter, the maximum of 2,500 words is still operative. Photo-engravings may be obtained by authors at cost.

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Nomenclature is important to the economic entomologist, possibly more so than to the specialist, since the latter works in closely restricted groups and on that account can deal with nomenclatural obstacles much more easily than those obliged to cover a broad field. Attention is therefore called to a proposal to modify our present system by the use of classifying prefixes. The problem will very likely come up for discussion before one or more of the scientific bodies at the coming annual meetings in Kansas City.

A great diversity in methods of controlling insects has developed in recent years and very properly so. The impossible of yesterday is becoming the commonplace of today. The kerosene emulsion and Paris green of early times are now represented by numerous preparations, many decidedly superior, and in addition we have nicotine sulphate, potassium, sodium and calcium cyanides and more recently some of the treacherous war gases. A number of these are deadly and a few extremely active. Familiarity breeds contempt and we have noted with some concern the casual way in which some of these materials have been handled in the field by those engaged in spraying, dusting, fumigating etc. This attitude is not always limited to the laborer, occasionally it is seen among the best informed. We owe it not only to ourselves but to the welfare of science as a whole that no unnecessary risks be taken in either experimental or practical work. In the case of the former there is always a chance of exhaustive investigations failing through an untimely development, while accidents of this nature in practical work may result in the condemnation of effective and reasonably safe measure. By all means be enthusiastic, but do not forget to temper action with discretion.

Obituary

WALTER DAVID HUNTER

Dr. W. D. HUNTER, President of the American Association of Economic Entomologists during the twenty-fifth year of its existence (1913), was born at Lincoln, Nebraska, December 14, 1875, and died suddenly of apoplexy at El Paso, Texas, October 13, 1925.

Unfortunately, I know nothing of Doctor Hunter's boyhood and early training. I hope to get some interesting information in regard to these matters, and especially as to the beginnings of his interest in entomology, for insertion in a subsequent biography to be published by the Entomological Society of Washington.

He graduated at the University of Nebraska with the degree of A. B. in 1895, and two years later was given the degree of M. A. During his postgraduate years he was an assistant to Prof. Lawrence Bruner, and began to publish as early as 1896, his first paper being entitled "A Contribution to the Knowledge of North American Syrphidae" (*Canadian Entomologist*, April, 1896). This was followed by three papers, also relating to the Syrphidae, during 1896 and 1897.

In the early part of 1897 Professor Bruner went to Argentina to undertake an investigation of the locust problem and remained in that country from June 1 until February 28 of the following year. During his absence Hunter was in charge of the college work in entomology.

His first connection with the federal entomological service was during this period. For a number of years Professor Bruner had made for the U. S. Department of Agriculture reconnaissance trips through the West to determine conditions of grasshopper prevalence in order that the western country might be forewarned of any increase of migratory grasshoppers which would threaten damage. During 1897 Hunter was commissioned by the Department to carry on this work during the summer months. This he did so carefully and so well that he was recommissioned the following summer to carry on an especial investigation to determine whether *Melanoplus spretus* breeds permanently in the Turtle Mountains in North Dakota.

In the late nineties the State of Texas made appropriations for the investigation of the cotton boll weevil which then occupied a comparatively insignificant region in that State; and it was not until 1901 that the federal government began to make specific appropriations for work against this insect, which it had begun as early as 1894 but had stopped with the entrance of the State of Texas into the field. It thus became

W. H. Hunter

necessary to employ a well trained man who could devote his whole attention to this insect, and Hunter's name instantly suggested itself. He was then at Ames, Iowa, acting as an assistant to Professor H. E. Summers.

There is a great accumulation of interesting things more or less buried in the correspondence files here at Washington. The early letters from men now famous in our science often reveal traits that have helped them to success. Thus it is with Hunter. I wrote him inquiring as to the wherefor of his movements and as to his plans. He wrote January 12, 1901, explaining that he had left Nebraska on account of the reduction in Professor Bruner's State appropriation which obliged him to do away with all of his assistants. This had happened so unexpectedly that Hunter had not thought of looking for another position. When the first of July, 1900, came, the only opening was the one at Ames. The salary was only four hundred dollars a year. As Hunter wrote me, "This is not enough for a man to live decently on even here in the West. I considered the matter fully before I accepted and submitted to the fall. In spite of the fact that I could go out into teaching and earn four times what I am getting now, and contrary to the advice and wishes of my relatives who for a long time have been trying to have me give up entomological work and go into business where they have offered me good openings, I decided to come here. A little discouragement is not enough to make me give up the work I like and thus to remain in the line for promotion. I have seen many men start out in scientific work to arrive at the stage I occupy at present and then leave it to go into something that would bring them immediate money; and so many of them never got back to science that I decided the other way."

It was a fortunate thing for the country and for economic entomology in general that he resisted the influence of his family and a very natural desire for more money. He was appointed Special Field Agent February 25, 1901, and arrived in Washington in time to see the second inauguration of President McKinley.

In a long talk that I had with him at this time I found that he had posted himself as thoroughly as possible, not only on the subject of the cotton boll weevil but of all cotton insects and upon the culture of cotton in the United States. I urged him to devote his first summer to a very careful study on the spot of everything relating to cotton culture in the weevil-invaded region as well as in the other portions of the State. This he did in the most open-minded and comprehensive way, and the following year opened headquarters at Victoria, Texas, and began to

build up a staff of trained assistants. It is unnecessary here to go further into the details of his cotton boll weevil work. It was magnificent. It was monumental. Probably never before had any species of insect been studied as intensively. Year after year the work was carried on, and there was early developed a series of recommendations which, had they been followed by the planters, would have retarded very greatly the progress of the weevil and would have saved the country hundreds of millions of dollars. Through this work Hunter became very well known to the people of the South, and especially to the people of Texas, and he gained a high place in their esteem.

His work on the pink bollworm of cotton and his success in bringing about the extermination of this insect in Louisiana and its near extermination in Texas is well known, but very few of us in the North begin to realize the difficulties of this accomplishment. Facing pronounced opposition on the part of many people, his tact and his firmness and his resourcefulness eventually brought about the desired results, but, I fear, at the expense of his health.

Doctor Hunter, however, was by no means a one-sided entomologist. He was by no means a cotton entomologist only. He was a widely read man. Attracted at an early date to the subject of medical entomology, he became a close student of the rapidly increasing world literature on this subject. In 1909 he began to publish, his first paper being entitled "A Practical Demonstration of a Method for Controlling the Cattle Tick," and his second, an article published the same year in *Science* of November 12, entitled "Treatment of Certain Tick-Transmitted Diseases." In 1911 he published a large bulletin on the Rocky Mountain spotted fever tick with especial reference to its control in the Bitter Root Valley of Montana. The breadth of his knowledge in medical entomology was shown in a marked manner in his presidential address before the Association of Economic Entomologists in 1913. It was entitled "American Interest in Medical Entomology," and was one of the most interesting and important addresses in our whole list. Probably the peak of his general writings on this aspect of our science, however, was his presidential address before the Entomological Society of Washington in 1915, which was modestly entitled "Some Observations on Medical Entomology." This was a rarely interesting and important paper which can be read today with the same vivid interest with which we listened to it here in Washington ten years ago. The extent of his knowledge and the breadth of his reading as shown in this address were revelations even to his most intimate friends.

In the early days of his residence in Texas—in the early nineteen-hundreds—I went to Texas every year to go over his work with him and to travel with him over the boll-weevil-infested region. From the start I was impressed not only by his speedy grasp of the whole subject but especially by the ready way in which he accommodated himself to the whole atmosphere of the State. The Texas people appreciated him at once, and their respect for his opinions and their liking for him as a man grew constantly and rapidly. In less than three years Mr. Jefferson Johnson, the then Commissioner of Agriculture of the State, told me one day at Austin that if he wished an expert opinion on any subject relating to cotton culture he would ask Hunter first. What a striking statement this was, and what a lesson it should carry to all economic entomologists!

It is difficult to analyze the way by which he impressed and attracted many different sorts of people. He had a distinctly calm and judicial manner, but was not slow in his decisions. He never openly antagonized a man except in an important or critical situation. He was a man of very great tact, and was what we commonly call a good mixer. These qualities in part accounted for his success with the southern people and for his success as an administrator, which was very great. He had the respect and affection of his many assistants to a marked degree. As a public speaker he was forceful if not eloquent. He commanded instant attention and held his audiences.

The judicial quality of Doctor Hunter's mind fitted him peculiarly for his position as a member of the Federal Horticultural Board, that admirable institution which has been a storm-center among conflicting interests in the plant-growing industries. His work in Texas for the last few years on pink bollworm eradication has been a Federal Horticultural Board project, and it is doubtful that any other living man could have carried it on as well and as successfully as he has done.

Although engaged for the greater part of his active working life in administration rather than laboratory work, Doctor Hunter was distinctly a research man. His mind was of that type, and he not only suggested and directed research work of very high character but took active part in much of it. His bibliography covers more than one hundred titles.

The value of his work to the South was recognized by the Tulane University of New Orleans when they gave him the degree of LL.D. in 1916, and it has especially been expressed since his death in leading editorials in prominent southern journals. One of them is headed "South's Loss in Death of Doctor Hunter;" another one, "All the South

is his Debtor." The *Dallas Journal* of October 15th, after an appreciation of his work, added, "Dr. Hunter was more than a great entomologist, as many Texans who knew him will attest. He was a man of such mold and nature that his associates in service and a legion of friends held him in more than warm esteem. His fineness, his fairness and his genial companionableness made them love him. He drew men to him and held them, as a result."

To the readers of this JOURNAL—all economic entomologists—Hunter's work stands out in a bright light. In his comparatively short life he taught us many things.

L. O. HOWARD

HAROLD MAXWELL LEFROY, M.A., F.E.S., F.Z.S.

HAROLD MAXWELL LEFROY, M.A., F.E.S., F.Z.S., Professor of Entomology in the Imperial College of Science and Technology died October 14 from gas poisoning, being overcome by a new gas developed from lewisite. It was a most unfortunate outcome of several years of experimental work with fumigants. He was born Jan. 20, 1877, the fourth son of C. J. Maxwell Lefroy and Elizabeth Catherine M'Clintock, Itchel Manor, Crondal, Hants, England, and married Kathleen Hamilton, daughter of William O'Mara of British Guiana.

Graduated from Kings College, Cambridge, First-class Natural Science Tripos, 1898, the breadth of his experience and the place he held in his profession, is indicated by the positions he occupied. He was Entomologist to the Imperial Department of Agriculture for the West Indies, 1899–1903, a location which put him in intimate touch with work in both the United States and Canada. He was in this country at least once and met a number of American entomologists. He was Imperial Entomologist for India, 1903–1912, going from there to the position he occupied at the time of his death. He was also Honorary Curator, Insect House, Zoological Gardens from 1913—; Imperial Silk Specialist, India, 1915–'16, Tem. Lieut.-Col. Mesopotamian Expeditionary Force, 1916 and attached to the Royal Commission on Wheat Supplies, 1917–'18. His work in Mesopotamia made a valuable contribution to entomological sanitation in camps and duties in connection with wheat supplies took him to Australia for a time. Lefroy was interested in both practical and systematic work. He was the author of numerous articles in the West Indian Bulletin, Agricultural Journal of India and Memoirs of the Department of Agriculture,

India. His major publications are: Indian Insect Pests, 1906, Indian Insect Life, 1910 and Manual of Entomology, 1923—the two Indian volumes being admirably illustrated.

His personal acquaintance with the insects and insect problems of the West Indies, India, England and to a lesser extent Australia, gave him an outlook rarely equaled. His death removes one of the outstanding entomologists of his country.

E. P. FELT

Reviews

Animals of Land and Sea by AUSTIN CLARK, D. Van Nostrand Company, New York, pages i-xxiv, 1-276, 10 plates, 740 figures, 1925. Price $3.00.

The title is very suggestive of the book:—Straight to the point and without technicalities.

The author of this profusely and admirably illustrated work has given us a most readable and interesting account of the ecology of animals, their relations to each other and man. The chapter on biology and human welfare is an intimate picture of everyday biological contacts well worthy the careful attention of such an ecologist as the economic entomologist. It is an admirable presentation. There is much of interest for the entomologist in the chapters on Animal Names, Human Foods, Man as Food for Animals, Man's Chief Competitors, the Insects, More about Insects, Animal Flight and Life's Borderlands—all largely concerned with insects or at least presenting some curious facts. There are few scientific names. They seem unnecessary and in no way detract from the value of the book. It would seem preferable to have had the explanations of the figures under the illustrations rather than segregated.

The author has made a distinct contribution to the popular literature on natural history and has done it in such a manner as to hold the interest of the general naturalist without sacrificing accuracy. He has also produced a volume which many technical men will be glad to have at hand for ready reference.

E. P. FELT

Sorauer's Handbuch der Pflanzenkrankheiten, Volume 4, Tiersche Schadlinge an Nutzpflanzen, Part 1, 4th edition newly revised by Dr. L. REH with the collaboration of Dr. H. BLUNCK, Dr. K. FRIEDERICHS, Dr. F. STELLWAAG, Dr. S. WILKE and Dr. F. ZACHER, xvi + 483 pages, 218 text figures, Paul Parey, Berlin, 1925. Price 28 marks.

This volume on economic zoology in relation to plants gives a comprehensive account of the Protozoa, Nematodes, Annelids, Mollusks and certain Arthropods. Of the last, one finds accounts of Crustaceans, Myriapods, Arachnids and the follow-

ing Hexapods namely, Thysanura, Collembola, Odonata, Orthoptera, Embiidae, Psocidae, Isoptera, Thysanoptera, Trichoptera and Lepidoptera. The arrangement is systematic, there being a general summation of structural and biological data for the important groups and genera followed by a brief discussion of the injurious species. The work is largely entomological since some 340 pages are given to accounts of injurious insects, though many entomologists will find much of the preceding matter, especially that relating to eel worms, most useful. The numerous well selected references and large series of excellent illustrations add greatly to the value of a work which summarizes Asian, African, European and American literature falling within its scope. This is a very convenient volume for the scientist desirous of a ready means of acquainting himself with the economic status of a large number of species and therefore extremely servicable to economic entomologists, especially those connected with quarantine work.

E. P. FELT

Insects and Diseases of Man by CARROLL FOX, pp. i-xii, 1–349, illustrations 92, P. Blakiston's Son and Co., Philadelphia, 1925. Price $4.00.

The first part of this attractive volume deals with insects, giving enough to distinguish those which have a place in medical entomology and then taking up in some detail the groups in which disease carriers are found. The keys to some of the dipterous families, to the mosquitoes, adults and larvae, to the genera of the Oestridae, the more important genera of the Muscidae, the more common and widespread species of Sarcophaga, similar tables for the Calliphoridae, Calliphorini, the Lucini, the genera of the Siphonoptera, the families, sub-families and genera of the Anoplura, the genera of the Ixodidae, the Trombidiidae, Dermanyssidae, Tarsonomidae and Sarcoptidae indicate the scientific temper of the work and yet these are kept subordinated to the main purpose of making easy the recognition of the dangerous forms and conveying essential information concerning the various species. Field health officers, physicians and many entomologists can find no more convenient guide in this branch of science. This part concludes with a chapter on rodents, the part they play as disease carriers, methods of control and another on technique,—practical directions for the collection and treatment of material. There is also a well selected bibliography.

The second part deals with the diseases carried by arthropoda to the human host, the causative agent, the source of infection, mode of transmission, communicability, epidemiology, recognition characters, preventive and control measures, treatment of carriers, etc. These are handled in a detailed manner which will appeal to physicians in particular. This part gives methods for mosquito and rat control and model ordinances to meet the needs of such situations. The author's experience as a teacher and United States public health officer has enabled him to produce a truly practical guide upon this very important subject.

E. P. FELT

Manual of Injurious Insects by GLENN W. HERRICK, pp. i–vii, 1–489, figures 458, Henry Holt and Company, New York, 1925.

The book is a comprehensive, well illustrated, attractive volume covering in an authoritative manner an unusually large field and very conveniently arranged. The discussions of insecticides indicate a mastery of this important phase of entomology. The synopses of the chief insects attacking various trees and crops

must prove most helpful to the practical man as well as of assistance to the expert. The tabulation of insect stages occurring on apple trees in winter is unusual and very desirable, because such information has a definite practical value. The numerous maps indicating distribution are a desirable feature. The scope of the work is further indicated by the one or more chapters on fruit tree insects, and pests affecting vegetable crops, tobacco, stored grains, cotton and sugar cane, greenhouse plants, live-stock, poultry, and those troublesome in the house. There is also a chapter on poisonous insects and related forms and an appendix dealing briefly with the gipsy and brown-tail moths.

The individual accounts of the insects are most excellent, brief, limited to essentials and practical, and the selection of species most admirable. The excellent series of illustrations and the well selected references add greatly to the value of the book. The author has produced a very useful work which will commend itself most highly to all readers, both lay and professional, interested in practical phases of entomology. He has brought within the compass of one volume a remarkable amount of well ordered information.

E. P. FELT

Current Notes

Dr. E. P. Felt, State Entomologist, Albany, N. Y., completed his thirtieth year of service on September 14.

Dr. H. H. Knight, assistant professor of entomology, Iowa State College, has been advanced to an associate professorship.

Mr. J. W. Ingram of the Bureau of Entomology and stationed at Crowley, La., has visited California to investigate rice insects.

Messrs. L. H. Worthley and D. J. Caffrey have spent several weeks this fall in the western area infested by the European corn borer.

Recent appointments in the Entomological Branch, Canadian Department of Agriculture, are as follows: W. L. Putnam, corn borer work; L. V. Schnobb, gipsy moth work.

Mr. Perez Simmons of the Bureau of Entomology has recently returned from a trip to New England, where he was on vacation leave.

Mr. Archie N. Tissot has recently been appointed assistant entomologist of the Florida Station, vice A. H. Beyer, who has resigned to take up graduate work.

Mr. W. H. Thompson, assistant entomologist, Florida State Plant Board, and engaged in citrus aphis investigations has recently been appointed assistant entomologist of the Florida Station.

Dr. Wm. Barnes, of Decatur, Ill., recently spent several days in the Division of Insects, U. S. National Museum, comparing types and consulting with specialists in Lepidoptera.

According to *Science*, the first radio talk of the season of the Smithsonian Institution, entitled "Flies" by Dr. J. M. Aldrich, was given from Station WRC on October 1.

The following appointments have been made recently in the Bureau of Entomology: Miss Grace E. Glance, Junior Entomologist, Investigations of Coccidae; Frank H. Shirck, Junior Entomologist, Toppenish, Wash.

According to *Science*, Glenn W. Herrick, professor of entomology in the College of Agriculture of Cornell University, is going abroad to spend his sabbatic leave visiting entomologists and laboratories in France and Italy.

Transfers in the Bureau of Entomology are announced as follows: Walter Carter, Toppenish, Wash., to Twin Falls, Idaho; K. B. McKinney, J. U. Gilmore, H. E. Wallace and T. E. McNeel, temporarily to the Federal Horticultural Board.

Prof. A. V. Mitchener of the Manitoba Agricultural College visited the Entomological Branch at Ottawa, August 24–30, and occupied most of his time in determining insects which he had brought from the College collection.

Dr. W. H. Brittain, Truro, Nova Scotia, has recently accepted a two year appointment from the American Cyanamid Company to travel around the world and introduce calcium cyanide for the destruction of soil insects and rodents.

The Tennessee State Horticultural Society, State Nurserymen's Association and State Beekeepers' Association will hold their annual conventions during the last week of January at Chattanooga, Tenn. Prof. G. M. Bentley is secretary of all three organizations.

Mr. C. F. Stahl, formerly of the Bureau of Entomology and now studying sugarcane insects in Cuba for the Tropical Plant Research Foundation, was a recent visitor at the Sugarcane Insect Laboratory at New Orleans, La.

Messrs. C. R. Twinn and W. A. Fowler of the Entomological Branch, Canadian Department of Agriculture, visited the principal greenhouses around Toronto, September 7–12. The tarnished plant bug and the greenhouse leaf-tyer were the most prevalent pests.

Mr. Samuel E. Cassino of Salem, Mass., visited the Entomological Branch, Ottawa, Can., on September 12, and spent some time examining geometers of the genus *Eupithecia* in the National Collection, with which he was much impressed.

Mr. Jos. B. Polivka, who has been employed as deputy apiary inspector in Wisconsin during the past summer, left Madison to join the European corn borer staff of the Ohio Experiment Station at Oak Harbor, Ohio, on October 3.

Prof. E. G. Kelly, Extension Entomologist, Kansas Agricultural College, Manhattan, Kans., has secured a year's leave of absence and is taking graduate work in entomology, Iowa State College, Ames, Iowa. Prof. Kelly is doing special work on the chemistry of certain insecticides.

Dr. F. C. Craighead has returned to the Bureau of Entomology after an extended trip inspecting field laboratories and control projects. The work at Asheville, N. C., Bogalusa, La., Petersham, Mass., and the Kaibab and Bitterroot National Forests was visited during the summer.

Dr. E. A. Back of the Bureau of Entomology returned to Washington on August 17, after examining, in Boston, Mass., large and valuable stocks of mohair and alpaca wools, in which clothes moths were multiplying in such numbers as to cause concern.

Mr. H. W. Allen, Associate Entomologist of the Mississippi Experiment Station, has been granted leave of absence and is enrolled in the graduate school of the Ohio State University, Columbus, Ohio.

Mr. Allen McIntosh, Assistant Professor of Zoology and Entomology at the Mississippi A. & M. College, has been enrolled in the graduate school of the University of Minnesota since June.

Mr. George E. Riley, for several years an inspector of the State Plant Board of Mississippi, has resigned to study medicine.

Mr. H. H. Wedgworth, inspector for the State Plant Board of Mississippi with headquarters at Raymond, Miss., has been granted leave of absence and is now in the graduate school of Cornell University.

Mr. R. P. Barnhart, for a number of years an inspector with the State Plant Board of Mississippi, with headquarters at Ocean Springs, Miss., died on July 21, 1923.

Mr. Jack P. Kislanko, a graduate of the University of Minnesota, accepted a position in the state entomological work in Mississippi, beginning October 1, 1925.

Mr. R. C. Price, for several years an inspector of the Mississippi State Plant Board with headquarters at Poplarville, Miss., resigned December 1 to accept a position with the Niagara Sprayer Company.

Mr. John O. Pepper is now connected with the Extension Service of Clemson Agricultural College, S. C., as Extension Entomologist of the State. He began his duties June 1.

Mr. J. E. Lee, for the past two years connected with the Barber Entomological Laboratories, New Orleans, La., has again accepted a position as an inspector with the State Plant Board of Mississippi.

Prof. E. W. Stafford returned this fall to take up his teaching duties at the Mississippi A. & M. College. He has been in the graduate school at the University of Minnesota during the past summer, and also during the greater part of the time for the past two years.

Mr. M. H. Davis, a recent graduate of the Mississippi A. & M. College, has been employed as Assistant Entomologist with the State Department of Agriculture at Raleigh, N. C.

Mr. W. V. Reed, formerly State Entomologist of Georgia, and later connected with the Federal Horticultural Board, has been appointed Nursery Inspector in North Carolina.

Mr. F. M. Hull, a graduate of the Mississippi A. & M. College, who recently received the M.S. degree at Ohio State University, has been appointed an instructor in zoology and entomology at the State College, Pullman, Wash.

During the past two months at least four counties in Mississippi have appropriated money for Argentine ant control campaigns. Hancock county leads the list with an appropriation of $7,000.00 for this purpose.

In connection with the recent corn ear worm outbreak in New Brunswick, Mr. R. P. Gorham reports an 80 per cent loss to sweet corn in some cases. Copies of a circular letter on corn ear worm control have been distributed among growers.

Among the graduates of the Mississippi A. &. M. College who have recently been employed as inspectors by the State Entomologist of Arizona, Dr. Oscar C. Bartlett,

are the following: J. C. Clark, R. O. Collier, H. C. Harling, G. C. Maddox, P. K. Harrison, and G. I. Worthington.

Mr. G. R. Williams, a graduate of the Mississippi A. & M. College, who was employed during the past summer by the Federal Insecticide & Fungicide Board, has recently been employed by the State Plant Board of Mississippi, as an inspector with headquarters at Durant, Miss.

Prof. William Lochhead has recently retired from the professorship of Entomology at McDonald College, Quebec, and will reside permanently at Ste. Anne de Bellevue, Quebec.

Mr. K. L. Cockerham, Biloxi, Miss., of the Division of Truck Crop Insect Investigations of the U. S. Bureau of Entomology, who is in charge of the sweet potato weevil work on the Gulf Coast of Mississippi and Alabama, recently spent several days at A. & M. College, Miss., in conference with members of the State Plant Board in regard to the sweet potato weevil work in that State.

Mr. David Dunavan, field assistant of the Bureau of Entomology, Toppenish, Wash., and Mr. J. N. Todd, of South Carolina, who has been working on the boll weevil in eastern South Carolina, are taking graduate work in entomology at Iowa State College, Ames, Iowa.

Dr. A. L. Quaintance, Acting Chief, Bureau of Entomology, Dr. T. J. Headlee, State Entomologist of New Jersey, and C. H. Hadley, Director, Bureau of Plant Industry, Harrisburg, Pa., visited the laboratory at Riverton, August 12, to discuss matters of policy relative to the Japanese beetle project.

Mr. Oliver I. Snapp, in charge of the Fort Valley, Ga., laboratory of the Bureau of Entomology, delivered an address on "Post harvest control of the curculio" at the fiftieth annual meeting of the Georgia State Horticultural Society in Athens, Ga., on August 24.

According to *Science*, Paul G. Howes, curator of natural history at the Bruce Museum of Greenwich, Conn., will leave in December for a collecting trip on the Isle of Dominica. It is planned to establish a permanent laboratory and base for the exploration of the Leeward Islands.

Mr. H. G. Barber spent about two weeks in August in the Section of Insects, U. S. National Museum, working on a catalogue of the Lygaeidae of the world, which he has undertaken in co-operation with other hemipterists who are preparing a catalogue of the Hemiptera of the world.

Prof. C. R. Jones, Associate Professor of Zoology and Entomology, Colorado Agricultural College, Fort Collins, Colo., has secured a leave of absence in order to pursue graduate work at Iowa State College, Ames, Iowa. Prof. Jones plans to spend the school year and summer sessions of the coming summer at Ames.

Several members of the Japanese Beetle Laboratory staff attended the annual meeting of the National Cranberry Growers' Association, held at Budd's Cranberry Bog, near Pemberton, N. J., August 26. In conjunction with the meeting a demonstration of airplane dusting of cranberries was given by the Morse Agricultural Service, New York City.

Mr. Arthur Gibson, Dominion Entomologist, has this fall visited the Entomological Branch laboratories in the Maritime Provinces, and during September, looked over the gipsy moth scouting work in Quebec. He also visited the laboratories at Chatham

and Vineland, Ont., and attended a meeting at Chatham to discuss the corn borer situation.

Mr. Robert J. Sim of the Japanese Beetle Laboratory, recently spent some time in the Division of Insects, U. S. National Museum, studying the collection of Scarabaeidae in an endeavor to identify the species which have been forwarded to the Japanese Beetle Laboratory in connection with the work on the Japanese beetle.

Dr. R. T. Cotton of the Bureau of Entomology has been on leave of absence since August 15, with headquarters at Ithaca, N. Y., making inspections of large wool warehouses and carpet and rug factories at Amsterdam, N. Y., for the purpose of giving advice on the protection of these products from clothes moths.

On August 28, Messrs. R. C. Roark and W. E. Kirby, of the Bureau of Chemistry, and Dr. Back and E. A. Vaughan, of the Bureau of Entomology, visited the Western Maryland Elevator Company in Baltimore, to be present at a demonstration of the fire hazards involved in the use of certain grain fumigants.

Following the discovery of the pine shoot moth in Toronto, further inspections of nurseries revealed the pest established at several points in southern Ontario on pines imported in recent years. Precautionary measures are being taken to prevent the shipment of infested material, and eradication work will be undertaken as soon as possible.

The following temporary positions in the Entomological Branch have been terminated: R. D. Bird, Treesbank, Manitoba; F. Jeffrey, Ottawa; Norman S. Cutler, C. E. Yauch, Aylmer Laboratory; H. H. Thomas, K. F. Auden, British Columbia; Miss Norma Bonell, Ottawa; D. T. Faulkner, R. Paradis, G. E. Dustan, R. Raynauld, H. Robert, F. P. Ide, N. A. Patterson, P. N. Vroom, G. S. Walley.

Mr. Arthur Kelsall of the Annapolis Royal, N. S., laboratory, accompanied by Mr. G. P. Walker, of the Fredericton, N. B., laboratory, visited the potato growing sections of Woodstock and Houlden on August 23, and later other sections of the State of Maine. Meetings of growers at Greene, Winterport and East Houlden were addressed by Mr. Kelsall.

Messrs. W. H. Larrimer, W. R. Walton, and L. H. Worthley of the Bureau of Entomology attended the corn borer conference held at Toledo, Detroit, and Windsor, Ontario, from September 29 to October 1, inclusive. They report a very large attendance and great interest on the part of the officials and others who attended this inspection trip and conference.

Dr. W. E. Britton has recently been appointed Superintendent of the State Geological and Natural History Survey of Connecticut and will carry on the new work in connection with his duties as State Entomologist. The Board of Commissioners of the Survey is composed of the Governor and the presidents of the five colleges and universities of the State.

Dr. A. G. Bôving of the Bureau of Entomology, has returned from his trip to Europe, where he spent considerable time studying the collections of beetle larvae in Copenhagen, Stockholm, and the British Museum. He met many of his colleagues and discussed various phases of his work with them, and arranged for large exchanges of adults and larvae of beetles.

The Entomological Branch, Canadian Department of Agriculture, had an attractive exhibit of insects and their work at the Canadian National Exhibition,

Toronto, August 29–September 12, prepared under the direction of Mr. C. B. Hutchings. Messrs. H. F. Hudson, A. A. Woods, J. A. Hall, C. R. Twinn, W. A. Fowler, J. G. McPharlin and C. W. Smith assisted at various times in disseminating information to the visiting public.

Professors S. B. Fracker and C. L. Fluke of the Wisconsin State College of Agriculture, visited the Entomological Laboratory at Chatham, Ontario, on September 24. On September 30, Mr. Baird explained the corn borer parasite work, conducted at this laboratory, to the 110 entomologists and other officials, chiefly from the United States, who were visiting areas in Ohio, Michigan and western Ontario, infested by the corn borer.

Dr. S. B. Fracker, Wisconsin State Entomologist, and C. L. Fluke of the Wisconsin Experiment Station, spent the week of September 21–26 investigating the work of the European corn borer in Ontario, Michigan and Ohio. Variety tests by the Agronomy Department to determine the latest profitable planting dates under Wisconsin conditions are planned to begin next spring, in anticipation of the borer's arrival in that State.

Mr. C. F. W. Muesebeck spent the month of October in the Division of Insects, U. S. National Museum, studying various parasites which have been reared in connection with the investigations of the Gipsy Moth Laboratory, and preparing a revision of the American braconid flies belonging to the subfamily Braconinae. On his way from Melrose Highlands to Washington, he stopped in New Haven and Philadelphia to examine types.

On August 20, Philadelphia daily papers carried accounts of a number of alleged cases of arsenic poisoning in the vicinity of Camden, N. J. as a result of eating fruit sprayed with arsenicals on account of the Japanese beetle. All of the alleged cases have been carefully investigated and no instances have been found in which there is any positive evidence that there was either illness or death occurring from this cause.

Messrs. J. V. Schaffner and H. I. Winchester of the gipsy moth parasite laboratory force, recently made a trip into northern New Jersey and the central and northern parts of New York, collecting native larvae, to determine the distribution of some of the introduced parasites of the gipsy moth (*Porthetria dispar*). One species has been recovered well beyond the gipsy moth dispersion line, and another one has been recovered from within the barrier zone.

Messrs. Loren B. Smith, B. R. Leach and J. P. Johnson of the Japanese beetle laboratory, Riverton, N. J., visited New Haven, Conn., October 28–30, where in company with the Director and Entomologists of the Connecticut Agricultural Experiment Station, they looked over the area infested with *Anomala orientalis* with a view to formulating some plan for repressive or exterminative measures. Injury from the grubs eating the roots of grass in lawns is more evident this fall than ever before.

Dr. Vernon Kellogg, Secretary of the National Research Council, has returned from Europe where he attended meetings of the International Research Council at Brussels, the League of Nations' Committee on International Intellectual Co-operation at Geneva, and the British Association for the Advancement of Science at Southampton. While in Belgium he was made Commander of the Order of Leopold by King Albert. Dr. Kellogg gave a paper before the Association of Universities in New Haven, October 30.

Mr. Raymond Shannon of the U. S. National Museum returned from Europe September 8. During his trip to Europe he had an opportunity to examine many of the types of Diptera, spending considerable time studying those belonging to the families Syrphidae, Muscidae, Calliphoridae, Culicidae, and Simuliidae. He was able to arrange extensive exchanges with various specialists throughout Europe and brought home nearly 1,000 specimens obtained in that manner. During his trip he collected about 1,000 specimens of flies, and obtained some very interesting records on distribution.

During the week of September 14, Messrs. H. L. Blaisdell and S. S. Crossman of the gipsy moth force of the Bureau of Entomology, made an inspection tour of the Barrier Zone from Pittsfield, Mass., north to the Canadian border, and visited some areas west of the Barrier Zone in the State of New York. L. E. Gibson and H. N. Bean, of the Scouting and Extermination Project, accompanied them on part of this trip. At Pittsfield a conference was held with H. L. McIntyre, of the New York State Conservation Commission.

Dr. J. M. Swaine, Entomological Branch, Canadian Department of Agriculture, left Ottawa on September 15 on a six weeks' trip to western Canada. En route he broke his journey at Frater, Ont., and Kippewa, Que., to view the forest sample plots located there. He later visited the laboratories at Indian Head, Sask., and Vernon, B. C., to discuss the investigational work with Messrs. J. J. deGryse and Ralph Hopping. On September 26, Dr. Swaine, accompanied by Mr. Hopping, left Vernon to visit beetle infested areas in Oregon and northern California.

Prof. Clarence H. Kennedy and Prof. James S. Hine, of the Ohio State University, visited the Division of Insects, U. S. National Museum, on their return from England, where they have been examining types in the British Museum (Natural History). Prof. Hine spent some time conferring with Dr. Aldrich and studying the collection of horse flies. Prof. Kennedy examined the collection of Odonata, spending considerable time studying the material coming from the Hawaiian Islands. He is preparing a revision of the Odonata of the Hawaiian Islands and has had an opportunity to examine practically all of the types.

The following resignations from the Bureau of Entomology have been announced: E. T. Evans, Riverton, N. J.; O. W. Carruthers, Brownwood, Tex.; Miss L. J. Kruger, O. T. Deen, Miss Winifred S. Hull, Lloyd M. Bertholf, Carlton E. Burnside, David Dunavan, Toppenish, Wash.; H. E. Brundrett, Dallas, Tex.; temporary appointments of the following have terminated: Messrs. DeLong, Beerman, Weatherby, Martin, Roberts, J. H. Adams, W. W. Brunson, J. E. Culpepper, C. Graham, J. H. Kyzar, C. W. Loden, R. Melvin, O. L. Turman, J. C. Wilkerson, W. H. Wilson, H. E. Woodruff, J. A. Bradley, J. F. Cooper, C. G. Latham, J. M. Lewis, G. E. McDaniel, E. H. McLaughlin, E. R. Purvis, J. W. Wilson and A. McF. Woodside.

The organization meeting of the Plant Conference Board of the Eastern and Middle Atlantic States was held at the American Museum of Natural History, New York City, September 29. Dr. T. J. Headlee, New Brunswick, N. J., was elected President, and E. N. Cory, College Park, Md., Secretary. The following entomologists were present: H. L. Bailey, Bradford, Vt.; W. E. Britton, New Haven, Conn.; E. N. Cory, College Park, Md.; T. J. Headlee, New Brunswick, N. J.; W. C. O'Kane, Durham, N. H.; H. L. McIntyre, Albany, N. Y.; W. E. Rumsey, Morgantown, W. Va.; W. J. Schoene, Blacksburg, Va.; A. E. Stene, Kingston, R. I.; and

B. D. Van Buren, Albany, N. Y.; and H. B. Weiss, Trenton, N. J. Also R. F. Clifton discussed the corn borer quarantine and Loren B. Smith the Japanese beetle quarantine.

Mr. J. E. Graf of the Bureau of Entomology visited the eastern shore of Virginia the latter part of September to go over the tuber moth situation with various officials representing the Experiment Station, State Entomologist's office, and Potato Growers' Association. A half day was spent in field inspection to obtain an idea of the infestation under field conditions and the possible factors which make it unusually heavy in the present season. After going over local conditions carefully, those present undertook to draw up suggestions for cultural measures to reduce the insect. Representatives from Virginia included Messrs. Johnson, Schoene and Strong, while Prof. Cory and Mr. Sanders were present from Maryland. Mr. Ralston represented the truck growers of the eastern shore.

Mr. Henry F. Bain of Seaside, Ore., has been appointed cranberry insect and disease specialist of Wisconsin. The work will consist of the discovery and control of incipient outbreaks of injurious pests and will be carried on under an appropriation to the State Entomologist of the State Department of Agriculture passed at the request of the Wisconsin Cranberry Growers' Association. Mr. Bain, who was formerly with the Federal Horticultural Board, will leave his position as assistant pathologist in charge of cranberry disease investigations in Oregon for the Federal Bureau of Plant Industry on March 1. He is a graduate of the University of Tennessee and holds a masters' degree from Brown University. His address in Wisconsin will be State Capitol, Madison, and his field headquarters will probably be at Wisconsin Rapids.

On August 7, orchardists and others from Burlington, Gloucester, and Camden Counties, N. J., held a meeting and tour for the purpose of looking over the investigational work at the Japanese beetle laboratory at Riverton and observing various methods of control in the field. About 100 acres of demonstration orchards were visited. The orchards consisted of peaches, apples, cherries and grapes. The growers expressed themselves as well pleased with the results obtained; almost perfect control was secured by following the recommendations issued by the laboratory on early ripening varieties of apples with one application of spray on June 25. During the trip a demonstration was held in one of the orchards, using a new attractive agent, geraniol, to draw the beetles into a limited area, where they can be killed by a contact spray. The contact spray, consisting of oleroresin of pyrethrum and soap, which has been developed at the laboratory during the past season, was also demonstrated with remarkably good results. The trip ended at the laboratory, where short talks were given by Dr. T. J. Headlee, State Entomologist of New Jersey, L. B. Smith and J. L. King.

Mr. S. M. Dohanian returned from Europe on the S. S. America on August 15, after spending most of the last six months in Spain and Portugal, investigating the biological control of the gipsy moth, *Porthetria dispar*. He has made several large shipments to Melrose Highlands, Mass., of gipsy moth larvae and pupae, and several lots of gipsy moth parasites and predators. As a result of these shipments, several parasite colonizations have been made. He reports heavy gipsy moth infestations in parts of Spain and Portugal. The parasitism of the gipsy moth, in these two countries was not so great as in parts of central Europe. He received splendid co-opera-

tion from the official entomologists in both Spain and Portugal, finding it a great help to the work. After the gipsy moth season was over in those countries he consulted with entomologists of the United States Bureau of Entomology at Hyeres, France, at Rome, Florence, and Fano, Italy, and at the meeting of the third International Congress of Entomologists at Zurich, Switzerland. In the southern part of France the gipsy moth infestation is very light, as it has been for several years. In southern Italy a heavy gipsy moth infestation is reported near Potenza, in the Province of Basilicata, and light infestations were located at Genoa and at Atessa, near Venice.

The Tropical Plant Research Foundation has recently received a request from Peru for its advice in regard to the establishment of a sugar and cotton experiment station in that country, with a suggestion that Mr. Arthur H. Rosenfeld, Special Technologist of the Porto Rican Insular Experiment Station, make a trip of a couple of months to Peru as the representative of the Foundation to report on the scope, location, financing and administration of such an institution. At the request of Dr. W. A. Orton, Director and General Manager of the Foundation, Mr. Rosenfeld has consented to obtain leave from his duties in "The Isle of Enchantment" and will start for Peru, after a conference with Dr. Orton in Washington, early in the coming year.

At the suggestion and through the efforts of Dr. Alexander Petrunkevitch, who is giving a course in Invertebrate Morphology at the University of Porto Rico this year, a Journal Club for those interested in the biological sciences has been organized, to meet every second and fourth Wednesday during the scholastic year. Besides Dr. Petrunkevitch, the following gentlemen, among others, are associated with the Club: Prof. Dale, head of the Department of Biology at the University; Dr. J. S. Dexter, Professor of Zoology, Miss Powers of the Course in Physiology; Dr. Mel T. Cook, Pathologist and Botanist of the Insular Experiment Station; Mr. Arthur H. Rosenfeld, Special Technologist, Insular Experiment Station; Mr. F. Sein, Assistant Entomologist, Insular Experiment Station, and Assistant Pathologist Toro, of the Insular Station. Two meetings of the Club have been held, at the first of which Dr. Cook discussed various phases of the mosaic disease of sugar cane and other plants. At the last meeting Dr. Petrunkevitch gave an informal and most interesting talk on spiders, their morphology, taxonomy, distribution and habits. Mr. Rosenfeld will talk on some phases of the sugar cane stalk borer at the next meeting.

The second meeting of entomologists working in Connecticut was held at the Connecticut Agricultural Experiment Station on October 30, 1925, beginning at 10:15 A. M. About 40 were present, and though the attendance was somewhat smaller than last year, deep interest was shown in the papers and many questions were asked and answered. The program was varied slightly from that of last year by requesting papers from certain men outside of Connecticut who are engaged in large control problems similar to those of the State, and in which Connecticut entomologists are interested. The following papers were presented: Notes on the Birch Leaf Skeletonizer, R. B. Friend, New Haven, Conn.; The Asiatic Beetle in Connecticut in 1925, M. P. Zappe, New Haven, Conn.; The Corn Borer Survey of 1925, L. H. Worthley, Arlington, Mass.; Oriental Peach Moth Survey, Dr. Alvah Peterson, Riverton, N. J.; The Japanese Beetle Survey of 1925, Loren B. Smith, Riverton, N. J.; Gipsy Moth Survey of 1925, A. F. Burgess, Melrose Highlands, Mass.; Progress in Controlling Curculio on Apple in 1925, Dr. Philip Garman, New Haven, Conn.;

Cucumber Beetles, Dr. H. C. Huckett, Riverhead, N. Y.; Anti-Mosquito Work of the Season in Connecticut, R. C. Botsford, New Haven, Conn.; The Birch Leaf-Miner in the Northeastern States, Dr. W. E. Britton, New Haven, Conn. The following were present: A. F. Burgess, S. S. Crossman, H. L. Blaisdell, T. H. Jones, Melrose Highlands, Mass.; H. A. Ames, Bound Brook, N. J.; S. E. May, Canaan, Conn.; F. C. Rich, Ansonia, Conn.; L. H. Worthley, T. M. Cannon, Arlington, Mass.; Loren B. Smith, J. Peter Johnson, Riverton, N. J.; H. C. Huckett, Riverhead, N. Y.; J. A. Manter, E. W. Nelson, R. S. Filmer, P. E. Bitgood, L. A. Gilbert, J. G. Conklin, Storrs, Conn.; O. W. Spicer, Stamford, Conn.; G. M. Codding, Mount Vernon, N. Y.; P. H. Meagher, Wallingford, Conn.; C. L. Marshall, Meriden, Conn.; D. W. Thomas, 2nd, Highwood, Conn.; G. A. Clyne, Waterbury, Conn.; Allen Latham, Norwichtown, Conn.; J. T. Ashworth, Danielson, Conn.; P. L. Buttrick, W. O. Filley, W. L. Slate, Jr., W. E. Britton, Philip Garman, B. H. Walden, M. P. Zappe, R. B. Friend, R. C. Botsford, Leslie Rogers, New Haven, Conn.

Messrs. R. T. Webber and P. B. Dowden, who have been investigating the gipsy moth and brown-tail moth and their natural enemies in central Europe during the last six months, returned to the gipsy moth laboratory at Melrose Highlands on September 4. Forest areas and entomologists were visited in Germany, Poland, Austria, Hungary, Jugoslavia, Czechoslovakia, Bulgaria, and Roumania. No infestations of sufficient intensity to allow for the carrying on of parasite introduction work were found in any of these countries except Hungary and Czechoslovakia. The areas in Poland and Hungary where gipsy moth parasite work was conducted the previous year were practically free of gipsy moth infestations this year, and new infested areas had to be found. Suitable infestations were located at Baja in the southern part of Hungary and at Bilky in northeastern Czechoslovakia. At these points temporary laboratories were established where parasite work was conducted during the season; from 300,000 to 400,000 gipsy moth larvae and pupae were handled at each of these locations and several fine parasite importations were made. As a result of this work, together with the work conducted by S. M. Dohanian in Spain and Portugal, approximately 40,000 tachinids have been placed in hibernation at the laboratory at Melrose and over 5,000 adults of multibrooded tachinids were liberated in gipsy moth infestations in New England during this summer. In addition to the tachinid material received, about 14,500 *A. vitripennis* were liberated in New England. Of this number 1,500 adults were liberated directly after they had been brought by T. H. Jones from Europe to Melrose Highlands. The other 13,000 were obtained at the Melrose Laboratory by breeding several generations on gipsy moth larvae, using European adult parasites for the original stock. Eight species of tachinids, six species of Hymenoptera, and three species of Coleoptera were involved in the European work this season.

Horticultural Inspection Notes

Mr. Jeff Chaffin, who recently held the position of Chief Nursery Inspector in Georgia, resigned September 15.

Word has just been received that Mr. L. R. Taft, Chief Horticulturist of Michigan, has resigned his position with that State.

Since the death of Dr. W. D. Hunter, his assistant Mr. F. S. Puckett, has been acting in charge of the Pink Bollworm Eradication work in Texas.

Mr. S. D. Whitlock, an inspector of the Federal Horticultural Board, has been transferred from his headquarters in Boston to San Juan, Porto Rico.

Mr. L. A. Strong, Assistant Director of Agriculture of the State of California, was in Washington recently for a conference with the Federal Horticultural Board.

The beetle, *Brachycerus albidentatus* Gyll., was intercepted in New York in a shipment of garlic on September 21. This insect is known to infest garlic in Corsica, Sicily and Sardinia.

Mr. J. A. Stevenson, who has been with the Federal Horticultural Board for a number of years, was recently transferred to the Office of Foreign Seed and Plant Introduction as Botanist in Charge of Agricultural Explorations.

Mr. Marcus McMasters resigned his position with the Federal Horticultural Board on October 31, to accept a position as the eastern representative of the Florist's Review magazine. Mr. McMasters has been stationed in New York since his appointment as Junior Plant Quarantine Inspector.

Mr. G. F. Moznette of the Bureau of Entomology has returned from a trip to the Isle of Pines and Cuba. Mr. Moznette made this trip at the request of the Federal Horticultural Board, to gather information in regard to insect infestation in the two Islands. He found the bean pod borer to be relatively plentiful in Cuba in lima beans and in other varieties.

One thousand certificates of nursery inspection have been issued by the office of the State Entomologist of Tennessee, 65 pending, and these will doubtless be released soon. One hundred fifty certificates on sweet potato certification were issued. The inspection force at present are making examinations in the billing yards of the nurserymen.

A coccid identified as *Chionaspis* or *Poliaspis* sp., possibly undescribed, was intercepted recently in New York on boxwood from Sweden. It is not believed that a similar insect has ever been reported as occurring on boxwood. Since publishing the last Notes in the JOURNAL OF ECONOMIC ENTOMOLOGY, the Mexican fruit fly, *Anastrepha ludens* Loew., and the West Indian fruit fly, *A. fraterculus* Wied., have been intercepted several times in fruits at ports of entry by inspectors of the Federal Horticultural Board. Specimens have also been taken which were identified from the larvae as *Anastrepha* sp. The Mediterranean fruit fly, *Ceratitis capitata*, has also been intercepted in apples from Malaga, Spain.

Apicultural Notes

The beekeepers of Holland held a national meeting the latter part of September.

The week from November 15–21 was set apart by the American Honey Producers' League as national honey week.

Mr. Virgil Argo, a graduate student in Cornell University, spent the summer in Maryland studying the bee louse, *Braula coeca*, which has become established there.

Dr. R. L. Parker has assumed his duties at the Kansas State Agricultural College as successor to Dr. Merrill.

Mr. C. P. Dadant, senior editor of the American Bee Journal, has been made an honorary member of the Société Centrale d'Apiculture.

A special three months' course is to be given at the Iowa Agricultural College beginning January 4, and among other subjects, is to include beekeeping.

An investigation of the bee louse, *Braula coeca*, is now in progress in France both at the apicultural research station at Montpelier, and also at the entomological station at Bordeaux.

Recent work by Dr. Himmer, an assistant of Dr. Zander at the Erlangen Bee Culture Institute, indicates that the so-called "May disease" of Europe is only a resultant effect of Nosema.

The annual meeting of the Northern Illinois and Southern Wisconsin Beekeepers Association was scheduled to be held at Rockford, Ill., October 20. Mr. Court D. Huggans, Polo, Ill., is Secreatry.

The fall meeting of the Connecticut Beekeepers' Association was held at the State Capitol, Hartford, Saturday, October 24. Prof. James I. Hambleton, Apiculturist of the Bureau of Entomology, Washington, D. C., was one of the principal speakers.

Mr. E. L. Sechrist of the Bee Culture Laboratory of the Bureau of Entomology, recently visited western comb-honey producers for the purpose of securing first-hand data relative to the problems connected with the grading of comb-honey.

Recent visitors at the Bee Culture Laboratory were: Prof. E. F. Phillips and Mr. Virgil Argo, of Cornell University; Prof. E. N. Cory of Maryland; Editor Freer of the Forum; and Mr. H. H. Root, General Manager of the A. I. Root Company.

A short course in Advanced Beekeeping will be held at Cornell University during the week of January 25. A special program devoted to bee diseases will be offered and considerable assistance from men outside the State is assured.

Dr. E. F. Phillips will attend the annual winter meeting of the Ohio State Beekeepers' Association at Columbus, Ohio, to be held during Farmers' Week at Ohio State University.

Messrs. Paul Needham and Everett Oertel, graduate students in beekeeping at Cornell University, acted as deputy apiary inspectors in New York State during the past summer. Mr. E. J. Anderson of the same institution did similar work in Pennsylvania.

An effort is being made through questionnaires sent out by the Bee Culture Laboratory of the Bureau of Entomology to obtain definite data as to honey plants and the nectar secreting-period of each in order that regional differences may be more thoroughly understood.

Recent publications of the U. S. Department of Agriculture include Department Circular 364, "The Color Grading of Honey" by E. L. Sechrist; Department Bulletin No. 1339, "The Effect of Weather upon the Change in Weight of a Colony of Bees during the Honey Flow" by Jas. I. Hambleton; and Department Bulletin No. 1349, "The Brood-Rearing Cycle of the Honeybee" by W. J. Nolan.

The beekeeping and honey exhibits at the State Fair, Nashville, Tenn., also the Tri-State Fair at Memphis were in charge of Mr. W. L. Walling, Tennessee State Apiarist. These exhibits were well installed and educational. The number of entries for premiums was larger than ever before. Mr. J. I. Hambleton, U. S. Apiculturist, Washington, D. C., attended the field meetings of the Tennessee State Bee-

keepers' Association at the queenery of John M. Davis, Spring Hill, Tenn., on September 8 and at the University of Tennessee yard on September 9. Those meetings were both well attended and addresses made by Mr. Hambleton, W. L. Walling, John M. Davis and G. M. Bentley.

The beekeeping exhibits at the East Tennessee Division Fair proved one of the features of the Fair. The exhibit covered 100 feet in space, consisting of living bees in observation hives, extracted chunk and section honey, posters showing the value of honey, photographs showing beekeeping yards and beekeeping manipulations. Candy, cookies and cake made with honey were also shown. In connection with these exhibits, a screen cage 30 feet long, 10 feet deep, was used for the demonstration of living bees, in which there were several colonies of Italian bees. Students from the beekeeping classes at the University of Tennessee, dressed in bathing suits demonstrated beekeeping manipulations. There were some 65 entries in the beekeeping department of the Fair.

Langstroth is called "the father of American beekeeping," and likewise Isaac Hopkins, who died on July 20, is known as "the father of Australasian beekeeping." His biography in The Australasian Beekeeper for August states that "it is to Mr. Isaac Hopkins that the honor of having introduced the Langstroth hive into Australasia belongs, and it was chiefly by his efforts through the press, etc., that the Langstroth hive is the universal hive in use in Australiasia today." Mr. Hopkins was the leader in many progressive apicultural methods in his section of the world. He began beekeeping in 1875 and edited the first beekeepers' journal in Australasia. His name and various articles by him have often appeared in American bee-journals.

The Cornell Beekeeping Library has received to November 1 gifts numbering 1780, not including purchases or the things which were in the Library previous to last February. These gifts come from 105 persons living in twenty-three states and ten foreign countries, showing a wide interest in the effort to establish a great beekeeping library. An interesting and important feature of this Library is the fact that collections of books and bee-journals which were formerly the property of leaders in beekeeping have been obtained, these being marked to constitute a memorial to these men. The Ohio State Beekeepers' Association has started a movement to establish a memorial endowment fund in memory of Rev. L. L. Langstroth in this Library and the organization is asking other associations to join them in this recognition of the value of the work of this great beekeeper.

The Beekeepers' Association of Alabama met at Montgomery, September 16–17, 1925. Twenty-five enthusiastic members attended the meetings. The program of the first day took up the reports of work done by officers of the Association during their vacation. Mr. J. I. Hambleton, Director of Bee Culture Laboratory, Bureau of Entomology, at Somerset, Maryland, was the principal out-of-state speaker. The meetings of the second day consisted of inspection of the queen yards of some queen breeders in Montgomery County. At the queen yard of Mr. J. M. Cutts, a picnic barbecue dinner was served. The afternoon meeting consisted of a discussion on shipping cages. The last business of the meeting was the election of officers. The officers for the year 1925–26 are as follows: President, J. Allen, Catherine; First Vice-President, J. M. Cutts, Montgomery; Second Vice-President, Jasper Knight, Montgomery; Third Vice-President, Mr. Merrell, Citronelle; Fourth Vice-President, Mr. Hogg, Ramer; Fifth Vice-President, M. C. Berry, Montgomery; Secretary-Treasurer, Elbert Harrell, Montgomery; and Assistant Secretary, J. M. Robinson, Auburn.

Notes on Medical Entomology

Messrs. W. V. King and G. H. Bradley of the Bureau of Entomology have been investigating the mosquito situation on the Mississippi coast.

According to *Science*, an international institute at Rome for the study and cure of malaria has been proposed at the International Anti-Malarial Congress in session there. The Italian government has promised support.

Major Harry A. Davis, who is in charge of mosquito investigations of the Army Medical Museum, visits the Division of Insects, U. S. National Museum, every two weeks to consult with Dr. Dyar, and have specimens identified.

Dr. Henry R. Carter, former Assistant Surgeon General of the United States Public Health Service, member of the National Malaria Committee, and known for his work on the control of yellow fever, died on September 8, aged sixty-two years.

Mr. O. G. Babcock of the Bureau of Entomology made an address on August 12 before a group of stock raisers at the "ranchman's roundup" held by the Texas Experiment Station at its substation No. 14, near Sonora, Tex. About one thousand ranchmen were in attendance, and considerable interest was shown in Mr. Babcock's discussion of the control of screwworms and goat lice under range conditions.

Dr. L. O. Howard, Chief, and Dr. W. V. King of the Bureau of Entomology, attended a conference called by Mayor Behrman of New Orleans to discuss the mosquito situation along the Gulf Coast. Dr. Howard was also the guest of honor at a dinner given at Gulfport, Miss., on the night of October 15, at which the mosquito situation was also discussed. Among those in attendance were the Mayor of Gulfport, the Secretary of the Chamber of Commerce, the County Health Officer, and Mr. M. M. High of the Bureau of Entomology.

Pacific Slope Notes

Mr. R. E. Dodge of Exeter, California, an enthusiastic collector of Lepidoptera, died during the summer.

Dr. Herbert J. Pack has returned to the Utah Experiment Station as Associate Entomologist after two years' study at Cornell University.

Messrs. W. W. Yothers, H. J. Quayle, H. S. Smith and P. H. Timberlake visited the laboratory of the Bureau of Entomology at Alhambra, Cal., August 19.

Mr. George Knowlton has returned to the Utah Experiment Station as an assistant in the Department of Entomology after a year spent in study at Ohio State University.

According to the *Pan-Pacific Entomologist*, Mr. A. J. Basinger of Riverside, Cal., has presented to the Entomological Department of the California Academy of Sciences, a collection of over 2,200 insects, including a very valuable and most welcome series of Alaskan Diptera.

Mr. C. J. Sorenson has resigned his position as Agricultural Inspector with the Utah State Board of Agriculture to accept appointment as Assistant Entomologist with the Utah Experiment Station. Mr. Sorenson will devote all of his time to research work under a new project dealing with the chalcis fly in alfalfa seed.

On July 31, Mr. W. D. Reed, of the Dried Fruit Laboratory of the Bureau of Entomology, returned to Fresno, Cal., after having surveyed the needs of a large terminal company of the Bay district in connection with the sterilization of stored products. On his return trip, Mr. Reed conferred with officials of the Prune and Apricot Growers' Association at San José.

The States of Utah and Idaho are co-operating with the Bureau of Entomology in a study of the white fly and its relation to curly-leaf in sugar-beets. The investigations will be directed by Dr. Walter Carter of the U. S. Bureau of Entomology, with headquarters at Twin Falls, Idaho. Dr. I. M. Hawley of the Utah Station and Professor Claude Wakeland of the Idaho Station are co-operating.

The Secretary of Agriculture has been advised by D. K. Grady, Secretary of the Dried Fruit Association of California, that this Association has appropriated $1,000.00 to aid the Bureau of Entomology in its investigations of dried-fruit insects. This action dupliçates that taken last year, and is an excellent endorsement of the work being conducted by J. C. Hamlin, who is in field charge of the investigations. Mr. Grady writes: "The Association has been very much interested in the investigation as it has developed to date, and is hopeful that the findings during the coming year will prove of material assistance to us in solving our infestation problem."

FOURTH INTERNATIONAL CONGRESS OF ENTOMOLOGY, 1928

The writer expects to present at the Kansas City meeting his report as delegate of the Association of Economic Entomologists to the Third International Congress of Entomology at Zurich, July 19–26, 1925.

In the meantime, so that American entomologists may have a chance to think about the fourth congress and to be prepared to discuss the possibility that it may be held in the United States, the following memorandum, prepared by Dr. Karl Jordan, the secretary of the third congress, as a result of the discussions by the Executive Committee at Zurich, is submitted.

In his accompanying letter, Doctor Jordan points out that the fourth congress, if held in the United States, will be essentially a gathering of American entomologists, but nevertheless every means should be employed to render it international. Doctor Jordan himself is coming to Washington possibly early in 1927 (and I hope he may be induced to come in 1926) to study Pulicid types in the National Museum.

L. O. HOWARD

Dr. Jordan's memorandum follows:

IV. INTERNATIONAL CONGRESS OF ENTOMOLOGY 1928

I. Attendance of the IV Congress by European Entomologists.

There may be a few Entomologists from Japan and other countries in the U. S. A. who will attend the Congress, but in order to make the gathering a success as an *International* Congress, a certain number of European Entomologists must be present, the more the better. Very few, however, can afford the expense of the voyage and of the sojourn in the States. A few may possibly receive a small grant from their governments or their Institutes. In such circumstances 10 would be an optimistic estimate of the number attending from Europe. The questions therefore arise as to whether it can be arranged:

1. That the foreign members of the Congress are the guests of the U. S. A. for a fortnight or so (as in the case of the Zoological Congress in 1904);

2. That a free passage to and from U. S. A. is extended to a certain number of European Entomologists, say a couple of dozen; and if that is not possible,

3. That the cost of the voyage is lowered by special arrangements with a shipping company.

If and when there is a fair prospect that these difficulties can be overcome, then we can proceed with the organization of the Congress itself.

II. Organization of the IV Congress. Preliminary steps.

1. Staff: Election of President, and appointment by him of a General Secretary, Treasurer and an Organization Committee assisting the three principals.—The Executive Committee would propose Dr. L. O. Howard as President.

2. Place and time (spring or autumn) of the meeting of the Congress.

3. Invitations would be issued in 1927; but a certain amount of publicity work would have to be done beforehand so as to arouse interest in the Congress, particularly among American Entomologists and the American public which supports Entomology.

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